Vol. XLVIII

OCTOBER 25th, 1945

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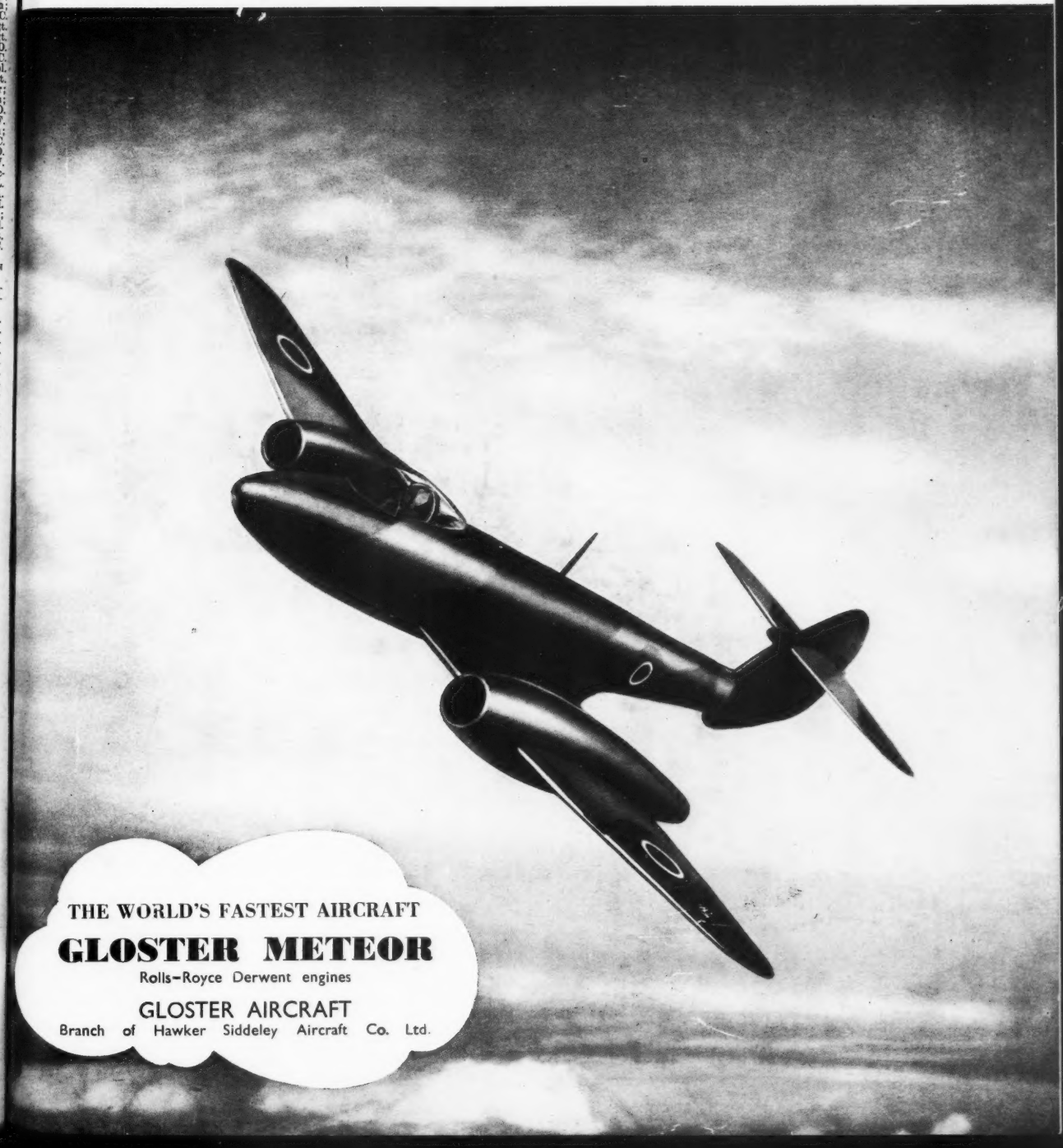

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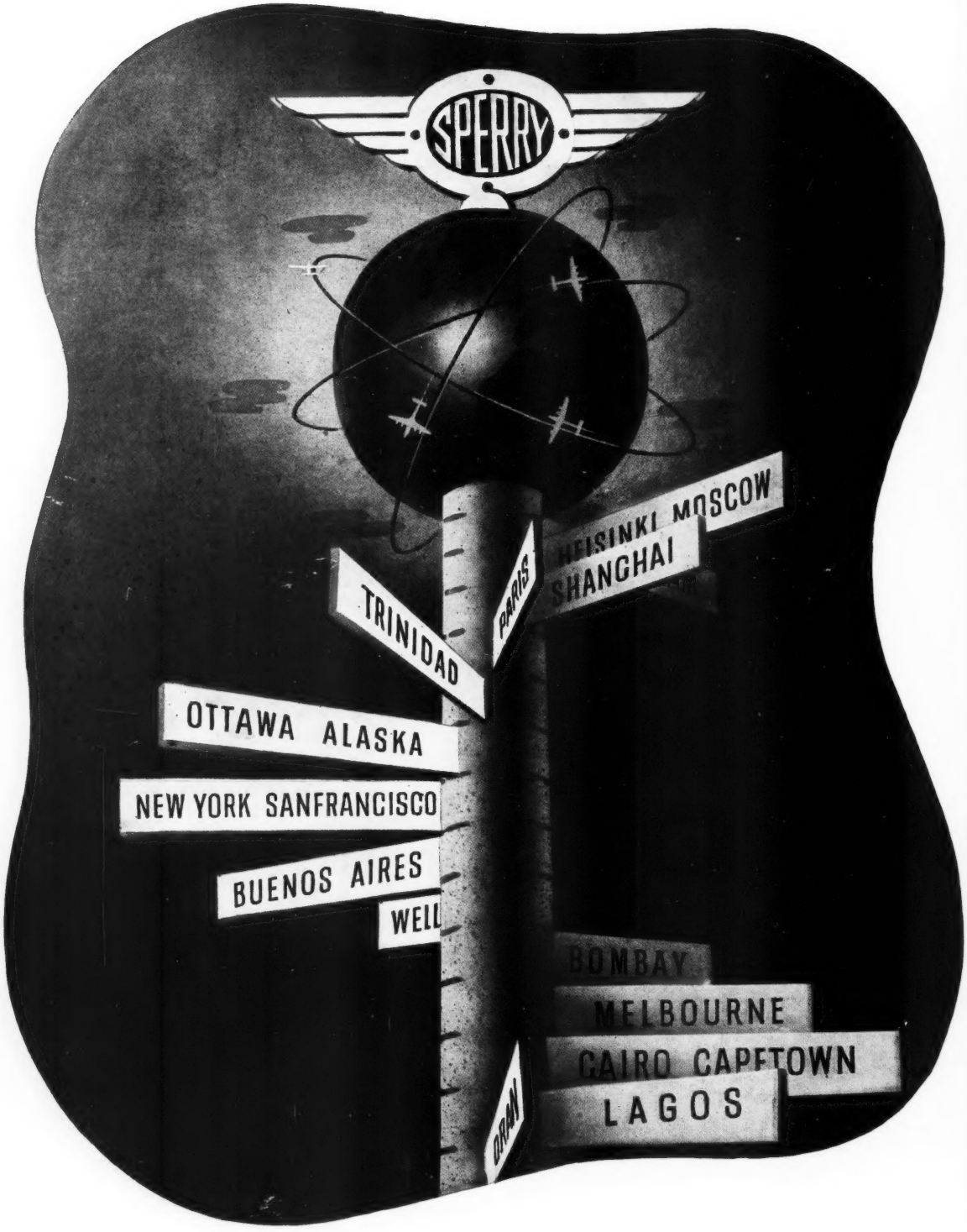

AIRCRAFT PRECISION NAVIGATION INSTRUMENTS

FLIGHT
and
AIRCRAFT ENGINEER

FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

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The Outlook

Alternating Ascendancy

ALTHOUGH it hardly seemed to be obvious enough to be encouraging in the dark days of 1940, the truth is probably that our comparative backwardness in aircraft production was one of the factors to save us at that critical period. Because we were late in starting, our fighter aircraft, in particular, were just so much better than they might have been if we had gone into quantity production a year sooner.

At the risk of being accused of wishful thinking, it is reasonable to suppose that history may repeat itself in the case of civil aircraft. We are hardly starting to get into our stride, and the manufacturers have been kept largely in ignorance of any Government plans, but it seems that when our projected civil aircraft are rolling out they will have the advantage of the locust years. Into these aircraft should be built all the experience, not only of our own military aircraft production, but, indirectly, of production, technical development and operating experience in the United States. They should be just that much better than the aircraft which are now about to go into service on the American air routes. When our aircraft are ready, the American transports may perhaps be dated, yet not old enough, on economic grounds, to be scrapped.

Most encouraging are the specification and estimated performance figures of the Airspeed Ambassador, the latest example of the "new generation" in transports. Whether the four-engined school of thought will persist in medium sizes, and whether the arguments in favour of two large and lightly loaded units are absolutely sound, we will leave the operator to decide, but it seems to us that this aircraft has not merely "something," but a large number of really outstanding features.

We hear, quite unofficially and possibly inaccurately, that the British Air Attaché in Washington has suggested that we should put in a tender covering the new medium-sized specification required by the American operators, and exemplified by the projected D.C.8 and the Martin 202. Of course, there is hardly a hope that a tender from this country would even be considered, but it might be a worthwhile gesture. The AS-57 should be able to compete on more than level terms.

Lords in the Air

BRITISH civil aviation at long last has "got a date." The debate in the House of Lords last Thursday drew from Lord Winster, Minister of Civil Aviation, the promise that he would announce the Government's policy on November 1st. In view of this fact, it was hardly surprising that no concrete answers were given to the various questions raised as to matters of operational policy. The Minister did, however, make certain statements which may indicate the trend of thought in Government circles on details rather than on broad policy.

Perhaps the most encouraging was his remark that British aircraft firms have to get into the export trade, and that he considered it his duty to foster that trade, one which could not be re-created without priority facilities. That statement will give some hope to the aircraft industry, which is ready and more than willing to "get cracking," if we may be permitted a slang expression, the moment the Government makes it possible to do so. Priority appears to be the key word, priority in materials and man-power. As Lord Brabazon rightly said, in British civil aviation to-day everything is in the air except the aircraft, although these are coming along in spite of the Government rather than because of it. The inauguration by two American concerns last week-end of services across the Atlantic lend point to the urgency of the situation.

The pleas of Viscounts St. Davids and Brentford for the resumption of gliding and private flying respectively will find a warm response in aviation circles, but Lord Winster was not particularly encouraging in his replies. He did not go beyond saying that the matter of a limited resumption of gliding was being discussed by the British Gliding Association, his Department, and the Air Ministry. There the only stumbling block is likely to be the Air Ministry, which seems to dislike all private flying whether powered or powerless, but probably prefers the latter—in both senses of the word.

When he turned to more technical subjects, the Minister of Civil Aviation became a little more encouraging. Concerning the importance of pressure cabins, he said that nine types of civil aircraft are being, or will be, developed by seven different companies, and he had taken some steps in the direction of a really comprehensive research unit. That is very good news.

And now we must await with what patience we may the announcement of the Government's policy on November 1st.

Meteoric

A NEW chapter in British aviation is about to be written this week. The attack on the world's speed record by two Gloster Meteors has caused at least a corner of the secrecy veil to be lifted, and the glimpse one is thus able to catch is more than a little intriguing and promises great things for the future.

Jet propulsion has made the attempt on the world's record possible, and for the first time in the history of flying the engine man has given the aircraft designer more power than he can as yet use fully and confidently. That is a very remarkable state of affairs. In the past when there was delay, as there nearly always was, the blame was inevitably placed at the door of the engine manufacturer. The new engine was not ready yet, or it was not giving the power promised, or it was much heavier than estimated originally. Now, almost in a flash, the position is entirely reversed, certainly so far as high-speed, short-range aircraft are concerned. That is a little disconcerting for the aircraft designer, but it promises very rapid progress during the next few years.

In this issue we have attempted to give our readers an idea of just how far our designers of aircraft and engines have gone in a very short time. It is not easy to paint a picture which will convey what all this progress really means. The jump forward is so stupendous that one is almost left gasping. To say that each of the Rolls-Royce units gives a thrust of 4,000 pounds, for example, does not mean much until one realises that at a speed of 600 m.p.h. it represents 6,400 h.p., or 12,800 h.p. for the two units. And even that does not tell the whole story. The weight of these units is remarkably low. Actual figures for the Derwent V may not be given, but it is but a small fraction of what would have been the corresponding weight of the piston engine of the same power. In other words, instead of speaking of pounds per horse-power, we now have to become accustomed to thinking in terms of horse-power per pound weight, or, rather, in thrust per pound weight. The first engine to pass the 100-hour type test developed more than two pounds thrust per pound weight. The Series V is a great deal better than that. Consumption is still high, but even this is being improved. For instance, we believe that the Derwent V achieves unity; that is to say, a pound of fuel per hour for every pound of thrust.

The contribution of the Gloster Company is that of designing a Service type of aircraft for about half the thrust now available, which is still good enough aerodynamically and strong enough structurally to be used for record flights at speeds so far in excess of any originally contemplated.

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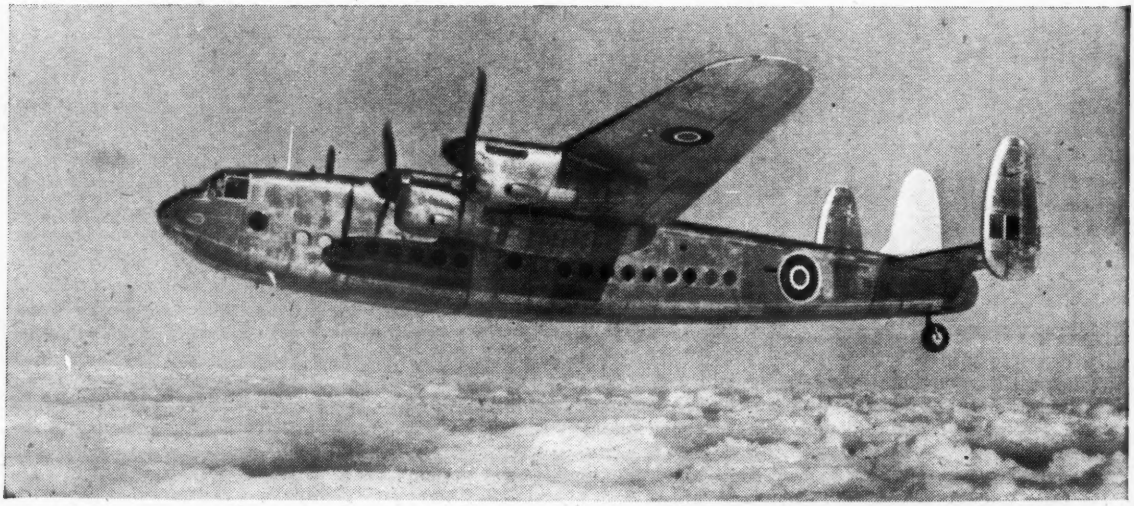


IN PEACETIME GARB: An uncamouflaged Avro York of R.A.F. Transport Command flying above the cloud layer in brilliant sunshine. Reflections from burnished aluminium are frequently so intense that areas around the pilot's cockpit are painted matt black.

What It Means

Record Run Seen from the "Inside"

SO many half-truths have been spoken and written about this business of "breaking the record" that it might be as well to try to clarify some aspects of the situation. At one end of the scale everyone has been talking very glibly of speeds over six hundred and thinking of the timed runs in terms of a few straight flights backwards and forwards along a particular length of seafront; and at the other end of the scale there are the people who imagine that a record run is just a question of finding out how fast a Meteor IV will fly and of timing it officially so that the record can be homologated.

Both ideas are right up to a point. So very much power is available that there is no doubt at all that the new series of special Derwent engines could push the Meteor along at speeds well in excess of ten miles a minute. And it has been, in fact, a question of finding out how fast the cleaned-up Meteor would fly—but while still under reasonable control.

To put it crudely, the Meteor has had to be jury-rigged to take the greater stresses of thrust and speed, while remaining controllable at that speed, and the pilots needed to discover, by trial and error, the top limit at which the aircraft could be accurately and safely handled.

That speed—plus the little extra which may be added by sheer personal courage—is to be the record figure.

During last week, Mr. Greenwood and Sqn. Ldr. Stanbury were making test flights to determine the kind and degree of minor modification required to maintain control, while Grp. Capt. Wilson, at Manston, was organising the details of the course and, with his detachment of the R.A.F. Test Pilots' School from Boscombe Down, making trial runs with Meteor IIIs to clear up timing, weather and course-keeping problems.

Low-level Handling

It says a very great deal for the inherent qualities of the Meteor when, with only comparatively minor modifications, it could even be considered as suitable for a series of high-speed runs at a maximum figure which is probably nearly a hundred miles an hour in excess of the originally highest permissible speed for the type. In the days when it was laid out, means and methods of designing to deal with compressibility effects had hardly been probed. Yet, in planning this attempt, those responsible must have had very good reasons for believing that no recently designed aircraft, at least outside this country, was capable of being handled at low level and at the speed it was hoped to attain with the modified Meteor. Maybe, when our friends across the Atlantic are ready to try to better our figure they will ask that the antediluvian F.A.I. ruling in the matter of height limits shall be modified

For handling peculiarities can be met, curbed and survived when height is measured in thousands of feet, but can hardly be permissible, except in very embryo form, when flying at a hundred feet—and that is the height at which the pilots fly on their runs, using the balloons at either end of the course as targets and making Rate Two left-hand turns round North Foreland and over the Isle of Sheppey to bring the aircraft back on to the line again. With so much power available there would be no advantage in climbing up to the officially permitted 1,300 ft. on the turns; indeed, since the object of the exercise was to fly as near as possible to, or just over, any borderline of handling difficulty, such tactics would involve the pilot unnecessarily and even dangerously in power and trim corrections at the worst possible moments. As far as the aircraft itself and the atmospheric conditions would allow, the pilot's situation has to be a sort of uncomfortable *status quo*.

Handling checks at high speeds were to be made at a height of about 4,000ft.—high enough to provide room for a reasonable amount of experimentation, yet not high enough, in normal weather conditions, to make any appreciable difference to the speed of sound and so alter the direct relationship of indicated air speed and relative handling characteristics. When the borderline maximum is checked it would be time to try the aircraft out at lower levels in smooth conditions. These last are vitally important to success since, quite obviously, any roughness in the air exaggerates any control difficulties and the speed would need to be reduced accordingly. The best results could only be obtained in ideal air conditions—and this ideal might have no connection, other than in the matter of plain visibility, with the apparent suitability of the weather. As far as visibility is concerned, anything in the region of ten miles is sufficient to enable the pilot to hold an accurate course and to return to this course without deviation after turning at the end of each run.

Final Limitations

Since the various modifications to the first Meteor had only just been completed last week-end and the aircraft had not reached Manston for final air checks, it was difficult then to know exactly what form the limiting handling difficulties would take in the modified aircraft. Primarily, of course, these would be concerned with what are usually covered by the general term "compressibility effects," but there would be quite a number of others, and the object of the initial tests and subsequent modifications have been to reduce these as far as possible.

The majority of people nowadays appear to be comparatively *au fait* with such things as shock waves and Mach numbers, and it will be enough to say that at high Mach numbers, varying with different aircraft, handling difficulties are experienced—the most usual being a change of longitudinal trim and the refusal of the elevators to correct this change.

This, in fact, formed the first sign of erratic behaviour in the Meteor, but, fortunately, this change of trim was in the "safe" direction—nose up. It occurred, one is told, at about 570 m.p.h. For a conventional design, the standard Meteor, one believes, can be flown comfortably at the high Mach number of 0.75, while the record aircraft probably does a good deal better than that. Yet there is nothing special about it.

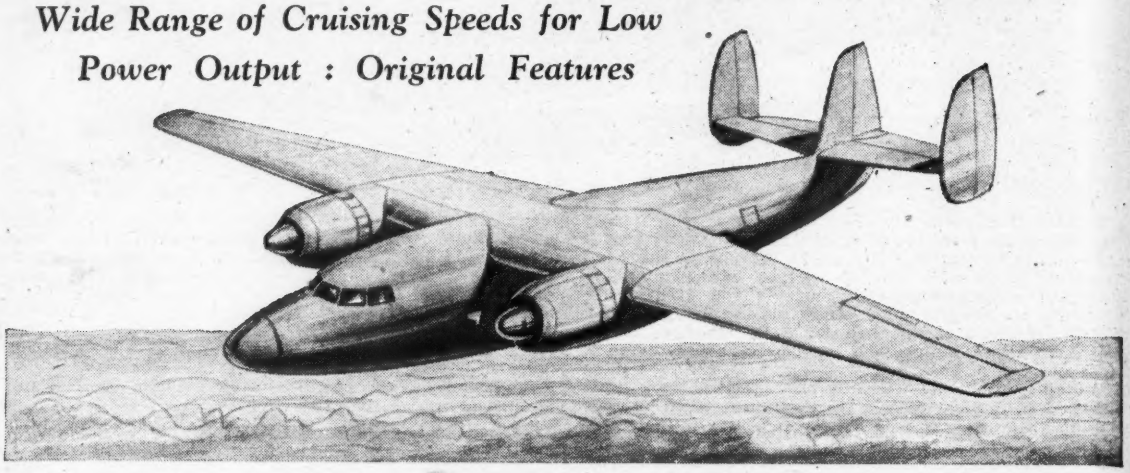
Of other effects which had to be dealt with, there was one which, apparently, is characteristic of jet-propelled aircraft—a tendency to directional instability. The need of really smooth conditions for the speed attempt is obvious. Then there were all the usual high-speed control problems, including prospective flutter, to be guarded against. All possible causes of flutter or over-balance had to be pinned down, and we believe that the record aircraft has both aileron and rudder servo tabs sealed up. This will make the controls somewhat heavy, but it was a small price to pay for freedom from trouble, and only low rates of turn were needed at each end of the run. Undercarriage and door up-latches had to be strengthened to remove any possibility that these would be sucked out and so make the aircraft uncontrollable. The hood had to be stiffened, too, and sealed down. Obviously, it was going to be exceedingly hot in a sealed cockpit, but any attempt at ventilation would have made it even hotter, and the development of a refrigeration system might have involved months of development work. The pilots would need to suffer patiently in discomfort for the short flying time involved.

With an eye on the future record attempts, a radar system of timing is unofficially used in addition to the normal synchronised camera methods If it is successful, and if the recorded figures match up with those officially obtained, then it may be possible to use it for later attempts when the F.A.I. rules covering the height limits have been modified. It is certainly difficult to visualise any other method of timing for speed runs at comparatively high altitudes.

The crux of the situation has been weather—and weather of a particular kind. Within reason, the question of visibility and cloud height was much less important than that of smoothness of the air over the course. The ideal has been a combination of ten-mile or more visibility, a cloud-base high enough for convenience, *and* comparatively bumpless conditions along the coast

Airspeed Ambassador (AS-57)

Encouraging Example of "Next Generation" of British Transports : Wide Range of Cruising Speeds for Low Power Output : Original Features



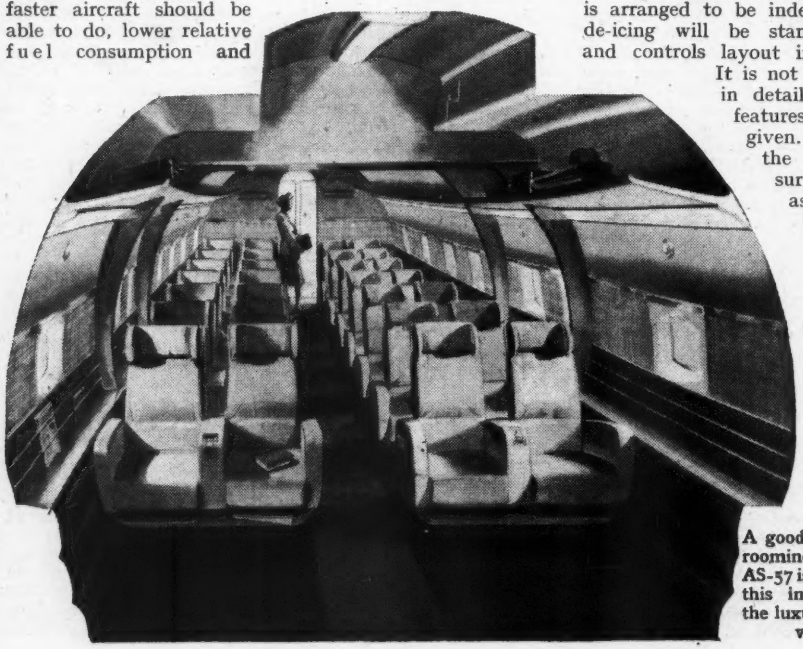
THAT there are ultimate advances to be gained from a temporary failure to keep abreast of civil aircraft development may be difficult to imagine. But, just as we are lagging in the production of military aircraft before and at the beginning of the war, giving us technical advantages in later years, so it is not unreasonable to suppose that in civil aircraft our time of ascendancy may come.

A good idea of the specification, features and relative efficiency of the transport of the intermediate future may be gained from a study of the Airspeed 57 Ambassador—an example of the "next generation" of British civil aircraft. With the accumulated experience of more than six years of aircraft manufacture all over the world and the immense amount of information now available, it is possible to offer the necessary high speeds without a comparable rise in operating costs. Even if we ignore the additional work which a faster aircraft should be able to do, lower relative fuel consumption and maintenance costs, following refinement in design, are now obtainable—and these two items are more than twice as important as fixed changes.

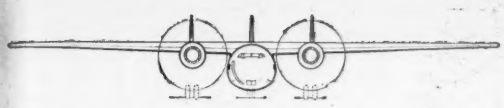
The Ambassador is a high-wing monoplane with a tricycle undercarriage and a moderate-wing loading to make it suitable for comparatively short range work and is powered by two Bristol Centaurus 57 engines. In brief outline and by way of introduction, the Ambassador is notable for the fact that it is designed to give a very wide range of cruising speed at a power output of less than 50 per cent. of the available total and, consequently, to give an exceptionally good rate of climb. Following naturally, the single-engine flying performance is outstanding and operating costs low.

New Ideas

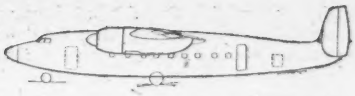
A number of interesting features have been incorporated. The fuselage, for instance, is designed for pressurisation in later production versions, while the cabin temperature is arranged to be independent of that outside; thermal de-icing will be standardised; while the instrument and controls layout includes a number of new ideas. It is not opportune at the moment to deal in detail with the design and structural features, but a general outline may be given. The wing, for instance, is of the low-drag type with a smooth surface to provide laminar flow as far aft as possible. It is of a higher aspect ratio than has previously been usual, while retaining an adequate thickness/chord ratio at the root. Alclad is used for the skin and, since this material cannot be rubbed down, means have been found to ensure that the rivet-head level is absolutely uniform. The bulk of the material used in the wing is in the skin, and with closely spaced stringers to keep the surface smooth under stresses. One of the objects of the high aspect ratio has been that of reducing the area of disturbed air behind the airscrew discs, leaving as



A good idea of the roominess of the AS-57 is provided by this impression of the luxury 28-seater version.



SPAN - - - 115ft.
HEIGHT - - 18.8ft.
LENGTH - - 80.25ft.



AIRSPEED AMBASSADOR (AS-57) (CONTINUED)

much as possible of the wing capable of laminar flow. Both the outer wings and the wing tips are detachable.

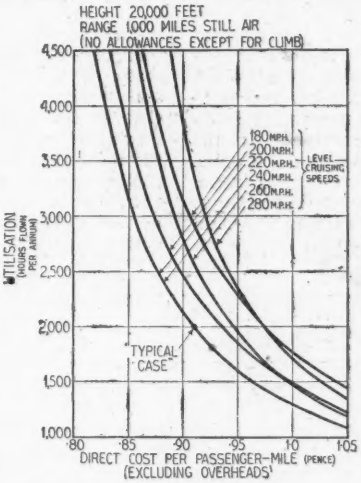
Built into the structure are the necessary ducts to carry the de-icing hot air. Briefly, the extreme nose of the wing forms an air pipe line, with the entire leading edge surface in sandwich form to enable this hot air to be distributed uniformly before it is led away to convenient points in the trailing edges. Three combustion heaters are used in the system, one in each engine nacelle, feeding the wings, and one, in the aft section of the fuselage, to feed the tail surfaces.

Isolating them from the stresses following a possibly heavy landing, the fuel tanks are outboard of the interchangeable power nacelles and integral with the wing spar, thus increasing the latter's stiffness in torsion. Covering twenty-five per cent. of the chord, the flaps are of the conventional split trailing-edge type. The ailerons are sealed and gear-tabbed, and are in three portions with universal couplings.

Pressurisation

In order to deal effectively with pressurising stresses, the fuselage is approximately of circular cross-section, with a larger radius used in the arc below the floor level for obvious reasons of practicability. With the high wing layout the interior, judging from an inspection of the mock-up, should be remarkably unobstructed between the cockpit and the rear pressure bulkhead. The prototype, which will not be pressurised, will be a 36-seater version. In this layout, taken from front to rear, there is a hinged nose-piece to take luggage and ancillary items; the pilots' and radio operator's cabin; the steward's galley and passenger luggage compartment; the passenger cabin; the two lavatories; and the aft luggage compartment. The passengers' compartment is well aft of the airscrew discs and, since these also have a low cruising tip-speed, the noise level should be comfortably low.

The pressurised, heated and ventilated area includes the pilots' compartment and, of course, the toilet rooms and main luggage compartment. Two engine-driven blowers maintain the fuselage pressure to that equivalent for 8,000ft. when flying at 20,000ft. Each blower is capable of delivering sufficient pressure by itself, with automatic relief valves to make the necessary allowances. Before being fed to the superchargers, the air is passed through heat exchangers to maintain an even temperature, and provision is made both for air-conditioning on the ground and for emergency ventilation in the unlikely event of complete engine failure. The unpressurised prototype is being made with large windows, but the area of these must naturally be somewhat more restricted in any pressurised layout; even so, with the help of a high-wing arrangement, the view from the passengers' seats is likely to be better than average.



A graph showing the direct cost per passenger/mile in relation to utilisation. The 40-passenger version is used in this comparison.

The tail unit carries triple fins and rudders. These are interconnected, and that in the centre carries an adjustable spring-servo tab, enabling control to be directly maintained on the rudder immediately after engine failure and ensuring lightness through the whole movement. The use of such a spring tab, coupled with the ample power reserve, gives the Ambassador its unusual single-engine performance.

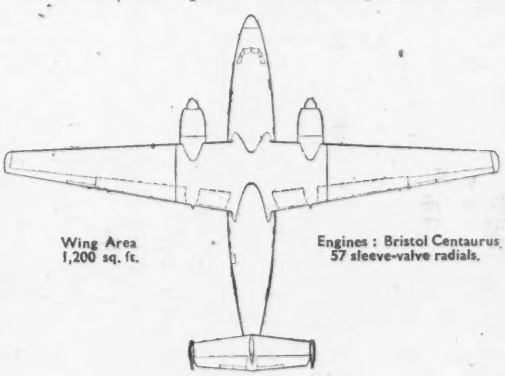
An interesting feature of the control system is the way in which those for the elevators and rudders are geared down in the control cabin and geared up again aft, so that the effects of fuselage contraction and expansion will be reduced to an absolute minimum.

Electric Power

In general, the auxiliary services are electrically operated—the flaps directly by electric motor and screw jack, and the undercarriage by motor hydraulic pump and three hydraulic jacks, one for each unit. There is obviously no point in arranging for a separate electric-hydraulic power-centre for each undercarriage unit since the failure of one will be as serious as the failure of all three. The legs lower in a rearward direction so that the action is completed by air-drag forces assisted by gravity, and the complications of an emergency system are unnecessary.

In order to keep the weight down and to reduce the overall capacity when retracted, all three undercarriage units are of the double-wheel type. Interestingly enough, the nose-wheel is arranged to be steerable through an hydraulic system, which gives an irreversible action and removes ground-to-rudder shocks. Since the Ambassador is designed to fly on one motor almost from the start of the take-off, considerable attention is being paid to means of reducing the overall drag of the aircraft when the undercarriage is down. The exposed legs are faired, and doors will be arranged to cover the undercarriage-housing gaps in the nacelles. Each main wheel is fitted with two pneumatic brakes.

Good reports have already been unofficially heard of the performance of the civil version of the British Centaurus which are at present being development-tested by B.O.A.C. in a Warwick, and these engines, at least during the first period of production, will be fitted to the Ambassador. The Centaurus 57 gives 2,580 h.p. for take-off, with an international rating of 2,200 h.p. and a consequent power-loading of 8.75 lb./b.h.p. at take-off. Each engine, with cooling systems, tanks and all accessories, is a self-contained "power egg," interchangeable from port to starboard and

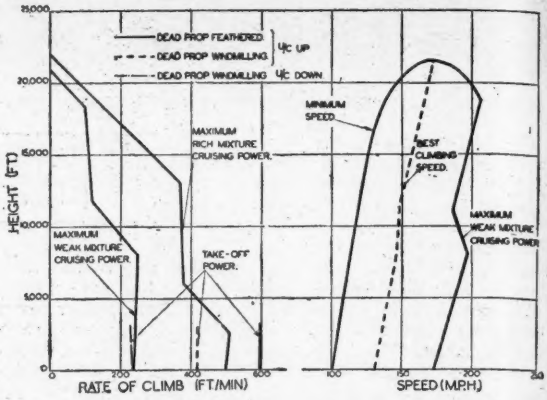


easily removed. Cruising at low revolutions—the optimum figure has not yet been fixed on test—the fuel consumption should be very low; a figure of 0.475 pts. per b.h.p./hr. has already been obtained. The de Havilland c.s. airscrews will, in due course, be of the reverse-pitch type for ground and emergency braking purposes. Cooling is by a geared fan.

Very special attention has been paid to the layout of the control cabin of the Ambassador in order to keep this as simple and as practical as possible, and the provisional arrangement includes a number of instruments and indicators which have not previously been standard on any aircraft. The control pedestal between the two pilots is quite one of the neatest we have ever seen, and an ingenious system of instrument lighting is being incorporated. A flight engineer is not carried, and all the engine instruments and controls are laid out for attention by the second pilot, while the pressurisation controls are handled by the radio operator, who is installed behind the captain.

Immediately below the anti-glare "scuttle" is a row of warning lights and emergency items. On the left, for instance, is a light labelled "take-off"; this light appears only when the controls are set for take-off and all hatches are shut. Next in order are the undercarriage indicator light, and airscrew reverse-pitch warning light, with, on the starboard side, engine check indicator-lights (which show when oil temperatures or pressures are low and when there is metal in the sump), and the test warning lights for checking the various indicators themselves. In the centre, duplicated for each engine, are the oil dilution switches, first extinguisher switches and fire-warning lights, feathering buttons, priming buttons, and starting buttons.

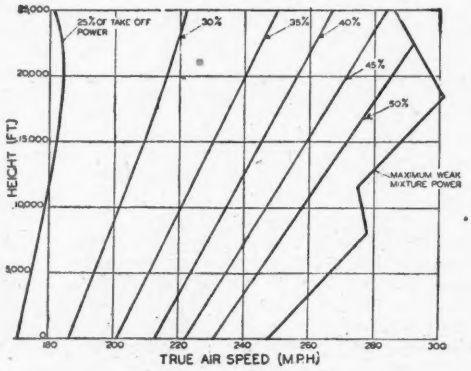
All the engine instruments are in the centre of the main panel, with a duplicated blind-flying panel for each pilot. The engine instruments include direct-reading fuel flow meters and engine torque meters—the "trouble" warning lights are above the feathering buttons so that the pilot will know immediately which of the two engines may have lost power and will be able to take rapid action in emergency conditions. The blind-flying panels are more comprehensive than those standardised in Service aircraft. In addition to the usual dials there are those for the repeater compass, radio D/F loop reading, and V.H.F. blind-approach indication. It is probable that the latest type of Smith-Farnborough automatic pilot will be fitted, and the control box, with its miniature control column, will be on the captain's left.



The rates of climb and speeds when flying on one engine. It will be seen that the Ambassador will fly comfortably at 45,000 lb. on weak-mixture cruising power.

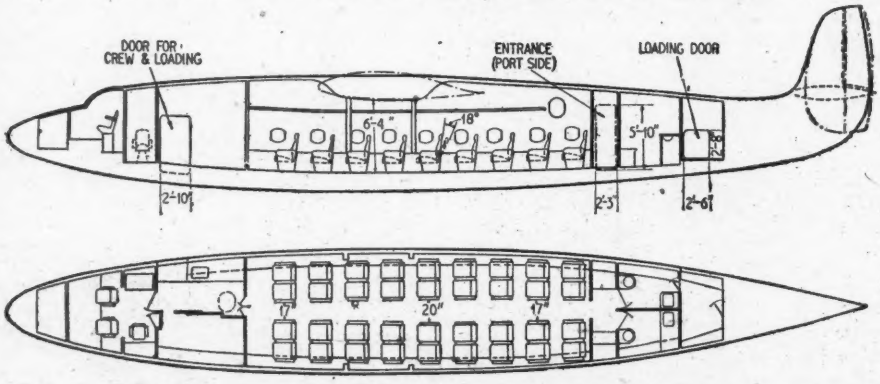
The control pedestal carries, conveniently arranged, the throttles, the undercarriage and flap controls, the automatic pilot cut-out, the trimming wheels for each axis, and duplicated control locks. The main trimming wheel, that for fore and aft adjustment, is a large one lying immediately beside and on the left of the throttles. On the right of the pedestal a small panel carries the electric cooling gill and oil temperature control switches.

In the mock-up layout no c.s. airscrew controls are to be seen. The idea is that these shall be inter-connected with the throttles. For the benefit of those who have experience only of the inter-connected system as standardised in certain fighter aircraft, it should be explained that the system to be used in this case will permit of a maximum degree of revolution adjustment by means of throttles manipulation. At each boost setting in the special gate there will be a considerable degree of free throttle movement which will not alter the boost, but can be used for synchronising the engine revolutions at these boost settings. In the fully back position of the throttles, through a gate, the airscrews will be coarsening off preparatory to feathering, while the reverse-pitch stop will be "error-proof."



The wide range of possible cruising speeds is adequately demonstrated in this graph showing power-percentages at different speeds and heights.

After a good deal of discussion it has been decided to standardise a pedal control braking system on lines familiar in American aircraft, but with an unusually ample range of relative movement between the braking and rudder controlling "areas" of the pedal plates. Coupled with the direct control-locking system in the cockpit and the "steerability" of the nosewheel, such a method of braking seems to be a logical one. The control columns branch up from each side, leaving



Plan and elevation diagrams of the Ambassador in the 36-passenger form of the prototype. There is an ample number of exits—emergency and otherwise.

AIRSPEED AMBASSADOR (AS-57)

the cabin unobstructed, aileron operation being by means of rods and bell cranks inside the column. It is probable that the cut-spectacle type of wheel control seen in the mock-up will be replaced by a form of half-wheel.

An entirely original "black-lighting" form of cockpit illumination is planned. In addition to more normal "bright" lighting from hidden lamps, each of the two control columns carries a small lamp directing its light towards the instrument panel. Each lamp is fitted with a screen which cuts off all but the ultra-violet rays, which are duly reflected by the fluorescent instrument dials. In practice, when these lights are on, all the instrument readings can be clearly seen with a light emanation rather greater than that obtainable in the case of unassisted luminous paint. After a long period in darkness it is probable that the crew will be able to see not only the instruments but a sufficiently faint outline of all essential controls. Certainly, in a blacked-out mock-up, there was no sign of reflection from either the two-piece flat screen or from the movable side panels.

In *Flight* of February 22nd this year the estimated cost figures for the Ambassador were given in an article which showed that, contrary to previously accepted opinion, a high cruising speed *can* be combined with economy in operation. The direct operating costs, excluding overheads, work out at £34.14 per hour. This figure is made up primarily of fuel and oil (£14.50), with airframe and engine maintenance at £5.76, flight crew costs at £3.45, "passenger service" (including insurance and stewards' pay) at £2, airframe and engine depreciation at £5.51, aircraft insurance at £1.88, and interest on investment at £0.88.

So many factors need to be considered in assessing commercial efficiency that it is impossible to include them in a reliable formula. The figures given have been based on recognised principles, but there are additional factors, in the case of all aircraft, which cannot be gauged without operating experience. For instance, the degree of "utilisation" depends on the reliability, and statistical evidence points to the fact that power plants and their components are more liable to be the subject of minor trouble than any other part of an aircraft. In theory, therefore, a twin-engined aircraft should, overall, be more efficient, for instance, than a four-engined aircraft. The cost figures have been worked for a cruising speed of 240 m.p.h. at 20,000ft., and it should be noted that the Ambassador, at this speed, is using only 37 per cent. of its take-off power. With such low power output it is reasonable to suppose that the maintenance costs will be lower still.

Fare Estimates

As far as direct operating costs are concerned, and treating the aircraft as being fully loaded on all trips, the figure works out at 0.91d. per passenger-mile. With an average of 60 per cent. filling, and provided that the overhead charges are not more than half the direct operating costs, the fare would need to be 2.28d. per passenger-mile for operation without loss or profit. "Utilisation" is, of course, the most important factor in air transport economy.

In the cost figures it has been assumed that the aircraft would put in 2,000 miles a year.

The reserve of available power, as previously outlined, should give the Ambassador a very wide range of permissible cruising speeds, as well as an exceptional single-engined performance. In the matter of cruising speeds, a variation of 0.30 to 0.50 of available power permits the pilot to modify his cruising speeds (between 10,000 to 20,000ft.) from 200 to 285 miles per hour, and the consequent consumption from 93 to 160 gal./hr. Naturally, such wide variations will enable the development and operational departments of an airline to produce cruising-control graphs to cover all possible conditions of wind and stage-length.

Weights, Dimensions and Loadings

Structure	16,570 lb.
Services and Equipment	2,020 lb.
Tare weight (40-seater)	30,755 lb.
Tare weight (24-seater)	30,715 lb.
Volume as a freighter	2,590 cu. ft.
Span	115ft.
Length	80.25ft.
Height	18.8ft.
Wing loading (45,000 lb.)	37.5 lb./sq. ft.
Span Loading (45,000 lb.)	3.4 lb./sq. ft.
Power loading	8.7 lb./b.h.p.

Payload and Passengers in Relation to Still-Air Range at 240 m.p.h. and 20,000ft.

Range (miles)	Payload (lb.)	No. Passengers
2,000	6,000	25
1,600	7,000	30
1,200	8,200	36
950	9,000	40
600	11,000	—

Estimated Climbing Performance

Take-off Power		Weak Mixture Power	
Height (ft.)	Rate of Climb (ft./min.)	Height (ft.)	Rate of Climb (ft./min.)
0	2,050	0	1,150
3,000	2,100	3,000	1,200
5,000	1,950	5,000	1,225
10,000	1,750	10,000	1,125
15,000	1,725	15,000	1,025
		20,000	900
		25,000	600
		30,000	225

Single-engined Performance

Taking the cruising figure of 240 m.p.h. at 20,000ft., and with a maximum disposable load of 14,245 lb., the still-air range, allowing for climb, is 1,000 miles with 40 passengers and a crew of four. In the same conditions, but with 24 passengers and a crew of five, the maximum range is 2,000 miles. In each case luggage and freight, to the extent of 60 lb. and 50 lb. respectively for each passenger, has been included, as well as all necessary "passenger service."

It follows that the combination of an ample reserve of power and low span loading provides an unusually good single-engined performance—which is, in fact, 20 per cent. better than the official requirements. The designers considered that the aircraft should be capable of taking off with a moderate rate of climb even when, in case of extreme emergency, the pilot was not able to retract the undercarriage or feather the airscrew, so, in addition to a cleaning-up of the aircraft in this condition, special attention was paid to rudder control. Not only are there three rudders of narrow chord and with sealed nose balances, but these are assisted by a spring servo-tab.

It is usual for the remaining engine of a twin flying at full load to be running in continuous rich mixture conditions. The A.S.57 still shows a wide speed-range and a ceiling of 18,000ft. at full load with the one engine at its weak mixture cruising settings. An accompanying graph (on the previous page) shows the aircraft's performances in these conditions.

In normal conditions the initial climb in weak mixture is 1,200 ft./min., while the distance taken to reach a height of 50ft. is only 750 yd. at take-off power, and the continuous rate of climb is 1,580 ft./min.

Altogether, Mr. A. E. Hagg, the Airspeed Technical Director and Chief Designer, his assistant, Mr. A. E. Ellison, and their staff can be congratulated on a really outstanding design. It is early yet to give possible dates of production, but work on test sections and jigs is already proceeding, and the firm expects the prototype to be in the air some twelve months from now.

MAIL RATE ANOMALY

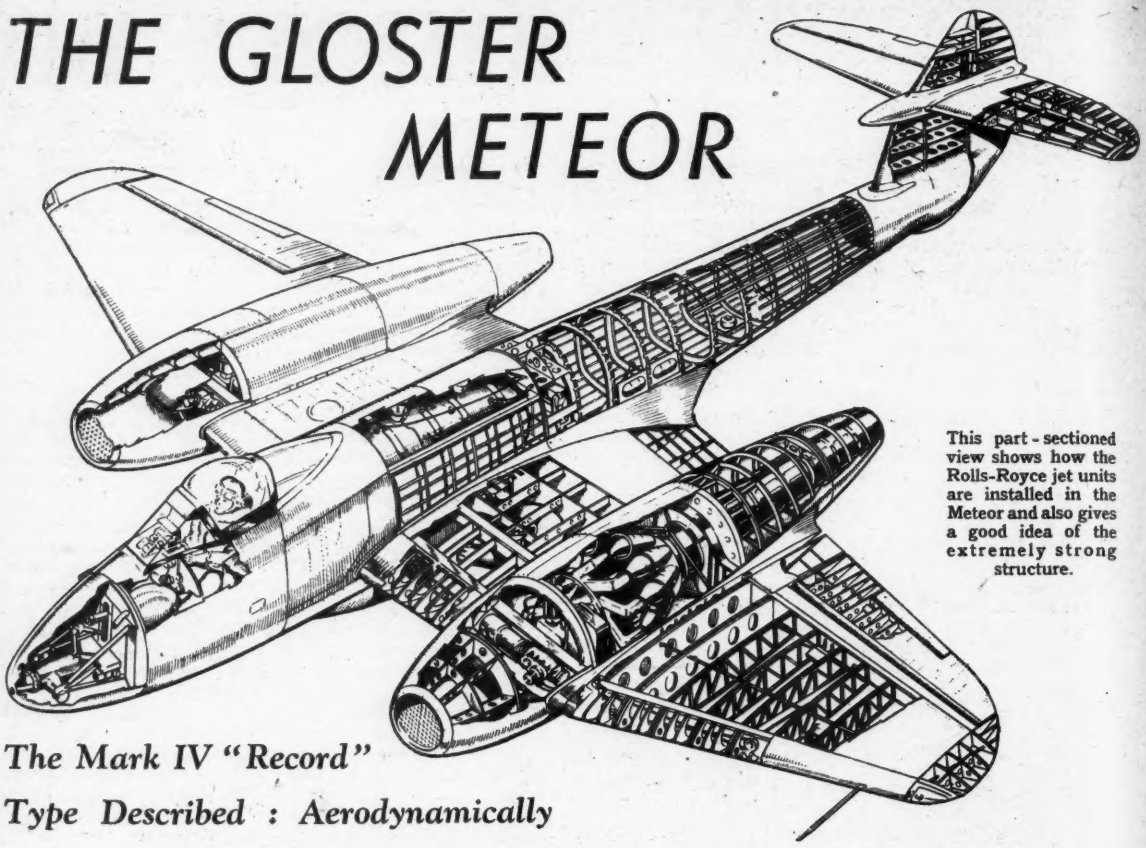
TO our perhaps mathematically feeble way of thinking, the present Empire mail rate of 1s. 3d. for every half-ounce seems to be a remarkably high one. Before the war the charge for all first-class Empire air mail was 1½d. per half-ounce.

The present figure is equivalent to £4,480 for the carriage of a ton—which represents about 28s. per ton/mile or 2s. 6d. per passenger/mile. The pre-war rate was equivalent to £448 per ton. The present charge is therefore ten times higher than it was.

In those days the average cost of carriage throughout the Empire was about 3d. per half-ounce, the mail being subsidised for the remainder. Whatever may be the additional costs incurred nowadays, it certainly seems that someone is profiting to the extent of 9d. or more every half-ounce of mail carried.

b

THE GLOSTER METEOR

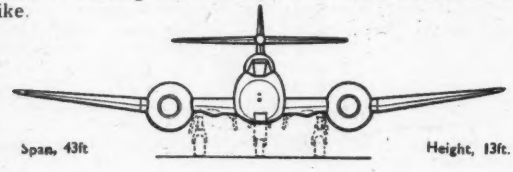


This part-sectioned view shows how the Rolls-Royce jet units are installed in the Meteor and also gives a good idea of the extremely strong structure.

The Mark IV "Record" Type Described : Aerodynamically Conventional Design

THE fact that a British firm should be able to attack the world's speed record so soon after the end of the war is a matter for congratulations to all concerned. One aspect which appears to have escaped general notice is that the Meteor is quite an orthodox aircraft. It could be simply described as a twin-engined, single-seater low-wing monoplane of all-metal construction and with tricycle undercarriage. One looks in vain for features which are now deemed necessary in really fast aircraft, such as laminar-flow wings with razor-sharp leading edges, very pointed and slim fuselage with no excrescences, and so forth.

In general design the Mark IV looks what it is in its workaday guise, a nice, not particularly small, single-seater fighter, which will be a very useful addition to the equipment of the R.A.F. It differs externally from the well-known Meteor III mainly in having longer power nacelles. The fuselage is identical with that of the Service version, built to house pilot and armament, and not tailored to fit the pilot like a glove. In view of all these things, we feel that Mr. W. G. Carter, its designer, is entitled to a pat on the back. It is no mean achievement to have demonstrated that an aircraft of strictly utilitarian design, with room in its fuselage for pilot, armament and full Service equipment, and wings thick enough to house the retracted undercarriage, can be pushed up to such speeds without running into trouble with shock waves and the like.



Span, 43ft Height, 13ft.

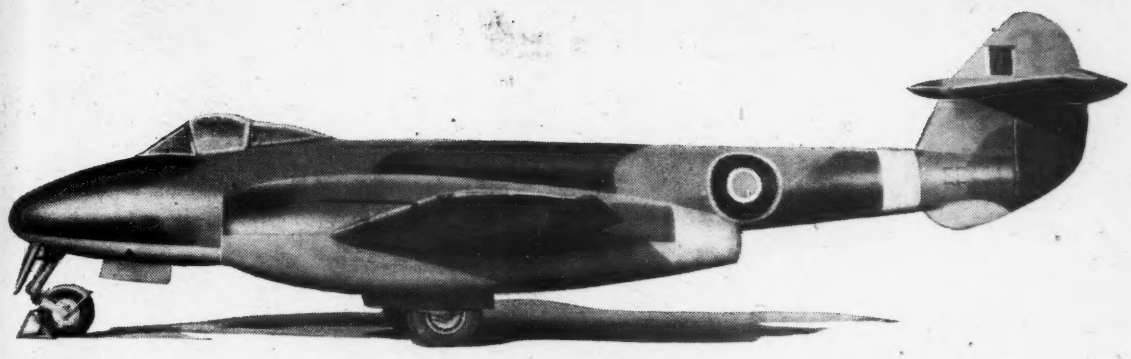
For the record the two Meteors are, of course, relieved of their military load, generally cleaned-up so far as surface finish is concerned, and structurally strengthened here and there to guard against any unusual stresses that might be set up by flying at some 80 per cent. of the speed of sound.

That the speeds are attained very largely by a prodigious output of power is obvious. The Rolls-Royce Derwent jet unit is fully described in this issue, but it goes without saying that for the record a good deal of extra thrust is demanded. It may be of interest to make an estimate of just how much that thrust is likely to amount to. The figures must of necessity be approximate, but they should serve to give some idea of what is involved in establishing a new record.

Thrust Required

From the fact that the Mark III Meteor weighs just over 12,000 lb., and bearing in mind the more powerful jet units of the record machines and the structural strengthening that has taken place, it appears reasonable to assume that the loaded weight is about 13,000 lb. The L/D of an aircraft at the top end of its speed range is very low, the maximum value occurring much closer to the stalling speed than to the top speed. It may be assumed that in the case of the Meteor the value is in the neighbourhood of 1.75, and if this figure is reasonably correct, the drag would be 7,430 lb., which would therefore be the thrust demanded from the power units. A thrust of 3,715 lb. from each unit is high, but by no means impossible.

Jet propulsion is still something of a novelty, and few people have become used to thinking in terms of thrust, so that the statement that a certain jet unit develops 3,715 lb. of thrust (in view of the high specific consumption it is sometimes referred to as "thirst"!) does not convey



In spite of the fact that it is basically a fighter with powerful armament and extensive equipment, the Meteor record machine looks very sleek with its lengthened nacelles.

very much. If, however, we translate it into the more familiar terms, it means that at 600 m.p.h., for example, 3,715 lb. of thrust represents 5,811 h.p., or a total for the Meteor of 11,622 h.p.! This figure is certainly not an exact one, but it does give an indication of the magnitude of the achievement.

The fact that the Meteor is in the world's record class is,

Mr. Eric Greenwood, chief test pilot, and Mr. F. McKenna, general manager of Glosters, who originated the idea of attacking the speed record.

of course, due to a period of steady though rapid development, not with speed records in view but to give the R.A.F. the fastest possible fighter, using jet-power units. The first experimental machine, it may be recalled, made its initial test flight in May, 1941, and had a single Whittle jet unit. The R.A.F. needed more speed and armament, and as at that time the prospects of the rapid development of a single unit giving really high thrust did not look very good, work was begun by the Gloster Company on a twin-engined design. It is this which, thanks to the almost incredible strides made by the jet unit firms, has developed into the Meteor IV record-breaker.

Comparisons

So quickly did things move that an early Meteor version was ready to be used operationally before the war with Germany ended. Just how far we have progressed since those days emerges from a brief examination of the Meteor III and IV. The former, with two Rolls-Royce jet units manufactured to the basic design of Air Commodore Whittle in collaboration with Power Jets, Ltd., and the British Thomson-Houston Co., Ltd., was fast enough for the German "Doodle Bugs," but not for some of the German jet- and rocket-propelled types. Its speed was in the neighbourhood of 460 m.p.h. at sea level and 475 m.p.h. at 30,000ft. The static thrust from each power unit was just under 2,000 lb., and the maximum rate of climb at sea level 4,000ft./min. It is interesting to point out that the Mach Numbers corresponding to the two speeds given were 0.61 and 0.70 respectively. For the benefit of readers not familiar with the meaning of the Mach Numbers it may be explained that they represent the percentage of the speed of sound at the height corresponding to the speed of the aircraft at that height. In other words, at sea level the aircraft sea level speed of 460 m.p.h. represents 61 per cent. of the speed of sound at sea level. At 30,000ft. the speed of sound has dropped, and 475 m.p.h. represents 70 per cent. of it. At 600 m.p.h. the Mach Number at sea level is in the neighbourhood of 0.80.

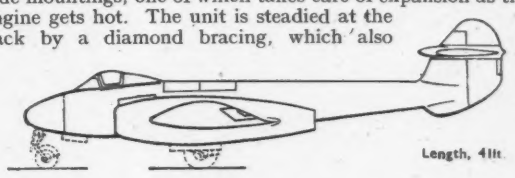
General Features

Basically, the record Meteor is the same as the Meteor III. The external geometry has not been altered except by the substitution of longer nacelles. At these high speeds the peak pressures on fuselage and nacelles are very high, and the lengthening of the nacelles separates the points of maximum pressures, thereby reducing the degree of interference.

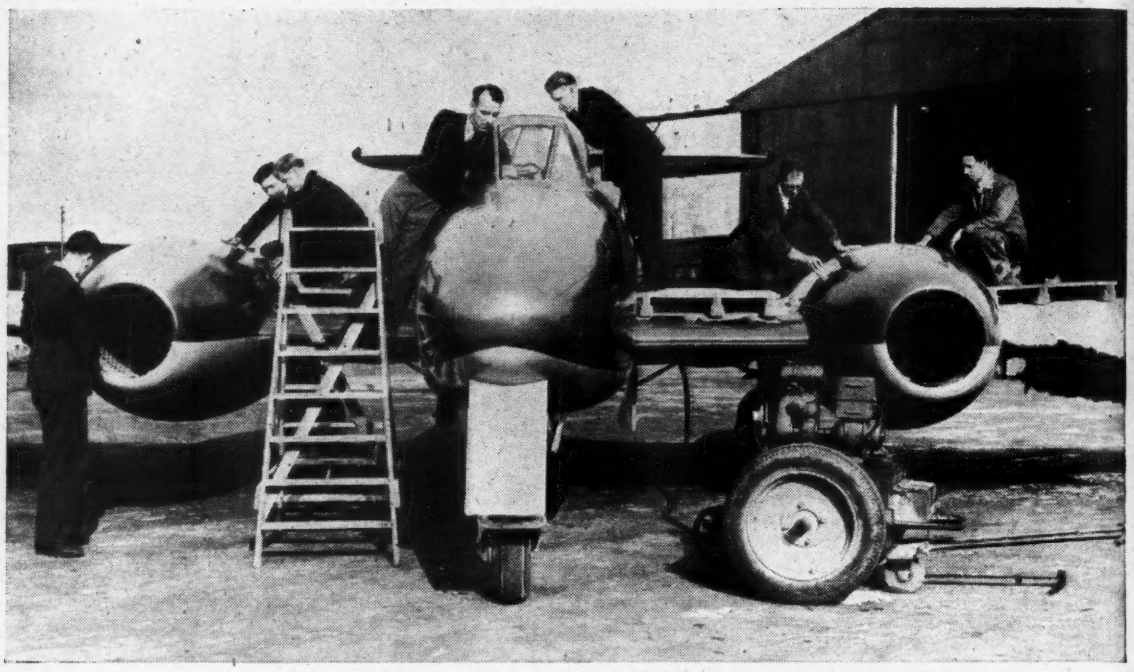
In the aerodynamic design of the Meteor there are no unusual features. The high setting of the tailplane is, of course, dictated by the need to get it out of the jet streams. The "acorn" fairing of the fin into the tailplane is not unusual, and has been seen previously on the Westland Whirlwind and Welkin. The high setting of the tailplane has necessitated splitting the rudder into two parts. Each elevator half is fitted with a trimming tab, and there is also one on the lower portion of the rudder.

Structurally, also, the Meteor is quite orthodox, with all components of stressed-skin construction, including the tail surfaces. The fuselage is built on the unit system, comprising nose, front fuselage (which incorporates pilot's cabin and houses the nose wheel), centre section with centre plane wing roots, rear fuselage and tail unit. Similarly the wings comprise the centre section, which is integral with the fuselage and carries the undercarriage units and nacelles, and the outer wing panels. The extreme wing tips are detachable.

The Rolls-Royce jet units are carried on trunnion-type side mountings, one of which takes care of expansion as the engine gets hot. The unit is steadied at the back by a diamond bracing, which also



Length, 41ft.

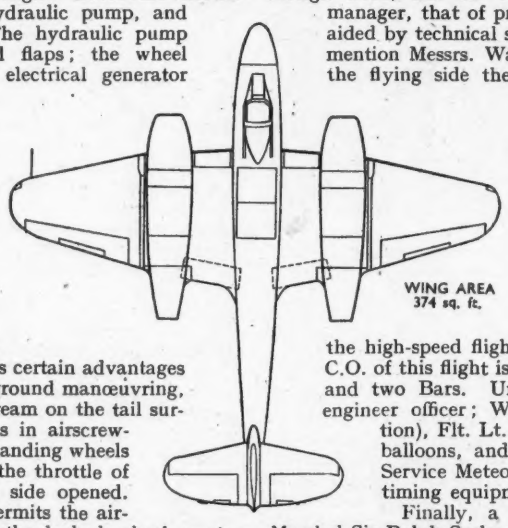


Grooming a challenger. All the work of preparing the Meteors for the record was done between the latter part of June (when the idea was first suggested) and last week-end, an achievement of which all concerned may be proud.

GLOSTER METEOR (Continued)

allows of expansion. In front of each engine is a Rotol accessory gear box driven by an extension shaft. The port engine drives the electric generator, the starboard the hydraulic pump, and both drive vacuum pumps. The hydraulic pump operates the undercarriage and flaps; the wheel brakes are air-operated. The electrical generator supplies power at 24 volts, 1,500 watts, and charges two 12-volt accumulators.

A tricycle undercarriage is fitted, the nose wheel as well as the main wheels being of the Dowty levered suspension type. The main wheels retract inwards and the nose wheel rearwards. Wheels and tyres are Dunlops. The nose wheel is, of course, castering, but is not steerable.



The tricycle undercarriage gives certain advantages on a jet-propelled aircraft. For ground manœuvring, for instance, as there is no slipstream on the tail surfaces such as that which obtains in airscrew-propelled types, one of the main landing wheels can be locked by its brake and the throttle of the power unit on the opposite side opened. The castering nose wheel then permits the aircraft to be swung around with the locked wheel as the centre of the turning circle.

The Men Behind the Scenes

When an achievement such as that represented by producing a challenger for world's speed records is attempted a large number of people play a part, many of whom the public never hears of. It is quite impossible to mention by name all of them, but we feel that in placing on record the chiefs of the various departments concerned we are, through them, paying a tribute to those too numerous to mention.

We have already stated that the idea of grooming the Meteor for record honours originated with Mr. F. McKenna, director and general manager of the Gloster Company. Mr. Carter, chief designer, bore the responsibility for the design work, Mr. R. V. Atkinson, director and works manager, that of production. They were, of course, aided by technical staffs, and in particular we should mention Messrs. Walker, James and Johnstone. On the flying side the testing has been done by Mr. Greenwood and Sqn. Ldr. Stanbury.

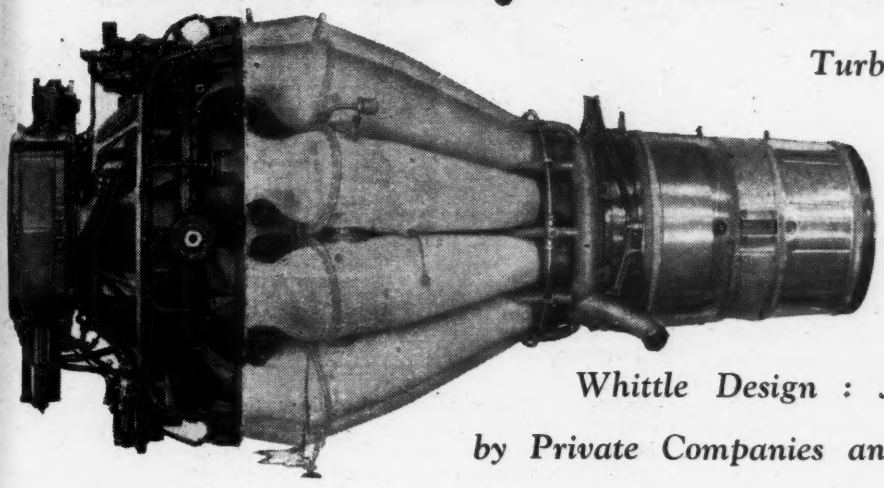
The Rolls-Royce team under Mr. E. W. Hives included Mr. A. G. Elliott, director and chief engineer, Dr. S. G. Hooker, assistant chief engineer, and Mr. J. P. Herriot, development engineer.

For the purpose of the record attempt a special flight was formed, rather similar to the high-speed flight of the Schneider Trophy days. C.O. of this flight is Grp. Capt. H. J. Wilson, A.F.C. and two Bars. Under him are Sqn. Ldr. Watts, engineer officer; Wing Cdr. McGregor (administration), Flt. Lt. Everson in charge of the marker balloons, and Flt. Lt. Clark, who has flown Service Meteors over the course for testing the timing equipment.

Finally, a tribute should be paid to Air Marshal Sir Ralph Sorley, who was Controller of Research and Development when the scheme started, and to his successor, Air Marshal Sir William Coryton, who has seen it through the later stages. The former took the decision to give the firms instructions to go ahead with the work, thus making the scheme possible of realisation, and the latter has helped in every way possible to facilitate the final preparations.

Altogether this record attempt is a splendid example of team work by the two construction firms and by the Air Ministry and Ministry of Aircraft Production. Enthusiasm and co-operation have achieved amazing results in a very short time.

Rolls-Royce Derwent



Turbine Jet Engines in the Gloster Meteor : Rapid Development of Original Whittle Design : Joint Enterprise by Private Companies and Air Ministry

THIS is more than a description of a new type of aircraft propulsion unit. It is an account, necessarily brief and incomplete, of a remarkable co-operative effort by individuals, firms and the State. Under war conditions every phase of the activity, the design, development, production and testing, had to be conducted in the closest secrecy, and to the credit of all concerned there were no leakages of information.

Tribute must be paid initially to Air Commodore F. Whittle. His was the first conception of the constant-pressure gas turbine and centrifugal compressor combination for a jet-propulsion unit. His first patent was deposited in 1930, and for a number of years it was only his dogged perseverance that overcame the indifference, lack of support, and even incredulity he encountered. It must be emphasised, however, that it was not merely a blind faith but an informed conviction that enabled him to continue his efforts. No more insistent advocates of this view could be found than Rolls-Royce officials concerned in the development of the engine. Although many mechanical and structural features have been altered, the original design was fundamentally sound aerodynamically. On the latest engines such vitally important components as the compressor and turbine still follow the original design or embody the original Whittle principles.

The first active interest of the Rolls-Royce organisation was in 1938 when, on the initiative of Mr. Hives, the general manager, a department for research and design of gas turbines for use as aircraft propulsion units was established. In 1940 testing rigs for aerofoils, bearings and combustion chambers were set up and the data accumulated were of great value in ensuing years in solving problems arising in engine development. Towards the end of 1940 the company was directly engaged in the manufacture of components for Whittle jet engines. Next year an intensive study of centrifugal compressors for Whittle engines was undertaken to ascertain the causes of and the means of eliminating surging. A special testing rig was built on which the compressors were driven by a Rolls-Royce Vulture engine developing 2,000 h.p.

All these activities were conducted as private ventures, but subsequently support was received from the Air Ministry. It must be remembered that in this period the organisation was heavily burdened with the development of piston engines for the war effort. Late in 1941, on Air Ministry direction, Rolls-Royce undertook the building of a Whittle-type engine designated WR1. At that time there were three major limiting factors, the turbine blades, operating temperatures and rotational speeds. The WR1 was designed with low blade stresses in order to demonstrate that the gas turbine could be made completely reliable. Considerations of weight and space occupied were subordinated to this end. Actually, with a maximum diameter of 54in. over the compressor casing and a weight of 1,100 lb., the engine developed a thrust of 2,000 lb. For the purpose intended this was regarded as quite satisfactory, and two engines were built for intensive test and investigation, and complete parts for a further six units were produced.

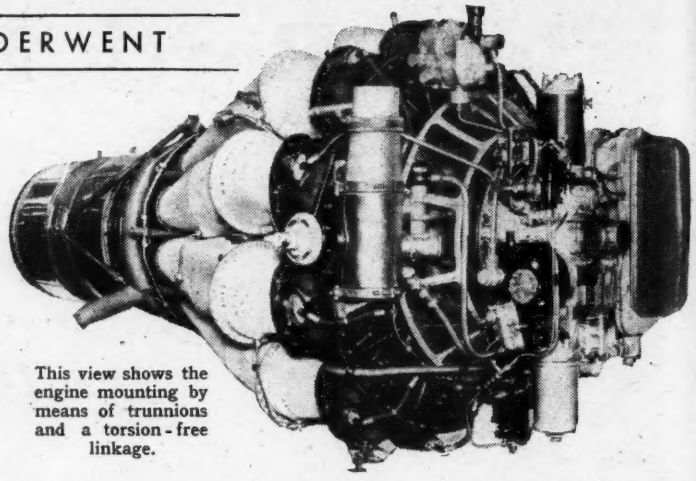
Jet History

The early history of the development of the Whittle engine was given by Air Commodore F. Whittle in a paper read before the Institution of Mechanical Engineers on October 5th, 1945, and reported in *Flight*, October 11th, 1945. This carried the development up to the W2B engine, which was built by the Rover Co. In March, 1943, Rolls-Royce took over the W2B/23 jet engine. At this period there was a parallel activity on the aircraft side. The Gloster Co. was proceeding with the design and development of a twin-engined, high-speed aircraft in readiness for the projected turbine jet units.

DATA

Compression ratio	3.9 : 1
Maximum jet pipe temperature	690 deg. C.
Rotation—viewed from rear	anti-clockwise
Thrust—combat and take-off	2,000 lb. at 16,600 r.p.m.
Thrust—cruising	1,550 lb. at 15,000 r.p.m.
Thrust—idling	120 lb. at 5,000 r.p.m.
Fuel	Aviation Kerosene
Fuel consumption—combat	2,360 lb./hr
Fuel consumption—cruising	1,820 lb./hr
Fuel consumption—idling	470 lb./hr
Lubricating oil tank capacity	22 pint
Lubricating oil consumption—all ratings	1 pt./hr

ROLLS-ROYCE DERWENT



This view shows the engine mounting by means of trunnions and a torsion-free linkage.

The Rolls-Royce organisation was able to employ flight facilities which had hitherto been lacking. Actually, it had the first flying test bed for jet engines at its disposal. This was a Wellington bomber which early in 1942 had been converted by Vickers to carry a jet engine in place of the normal tail turret. A complete set of testing and recording instruments was provided in a special compartment in the fuselage. This machine was capable of flight at altitudes up to 25,000ft., and the first series of tests extended over 25 hours running. The unit was then removed for examination, and a second series of tests was undertaken, involving a running time of 100 hours. A second Wellington, equipped with Merlin two-stage supercharged engines was subsequently converted for tests at altitudes up to 35,000ft., and in this form is still in use.

First 100-hour Test

Engines of the W2B/23 type, built by Rolls-Royce and named the Welland, were supplied for installation in the Gloster experimental E/28 single-engined aircraft and in April, 1943, a Welland made the first observed 100-hour run under type-test conditions. In June, 1943, two Welland units were installed in the Gloster F9/40, prototype of the Meteor aircraft. The engine had a maximum diameter of 43in. and weighed 850 lb. For the F9/40 it was rated for a thrust of 1,450 lb., although on test it gave 1,600 lb., and was later developed to 1,700 lb. thrust. Since that time there has never been less than six Meteor aircraft undergoing test.

The design was stabilised and production facilities were organised. By May, 1944, the engine was approved as possessing a reliability suitable for R.A.F. operations, and regular deliveries were commenced. It was at this time that the Welland established the first 500-hour run under type-test conditions. Actually, the engine was set up for a 100-hour test, and on its conclusion was continued for a further 400 hours under similar conditions. Prior to this the Air Ministry had rated the engine in service for a maximum of 80 hours running between overhauls. As a result of the 500-hour test the period between overhauls was stepped up to 180 hours.

Series I Derwent Designed

Whilst all these activities were proceeding Rolls-Royce decided to embark on a new design to embody the fruits of their development work. This new project was to be of the same maximum diameter for installation in the standard Meteor engine nacelles but to develop a static thrust of 2,000 lb. Work was commenced in the drawing office in April, 1943. By July it had been built and was placed on test, and in November, 1943, it passed its 100-hour type-test at 2,000 lb. thrust. In April of the next year it completed its first flight test in the Meteor with a service rating of 1,800 lb. thrust and weight of 920 lb.

In view of the satisfactory performance a programme of continuous development work was undertaken involving many 100-hour tests culminating in a successful 500-hour type-test. The new engine was known as the B37, R-R Derwent, Series I. The Series II engine gave an increased thrust of 2,200 lb. Series III was a special unit for experiments to provide suction on aircraft wing surfaces for boundary layer removal. Series IV gave a further increase in thrust to 2,400 lb.

This was not the only activity, however. New designs were being prepared, and much had been learnt from the continuous testing programme. The Derwent Series V, whilst retaining the maximum diameter of 43in., was an entirely new unit developing twice the thrust of the original Derwent I. It is this engine which enabled the Gloster Meteor to achieve its amazing speed.

This history of the Derwent engine to date demonstrates the phenomenally rapid development of turbine jet units. Turbine engines can be designed, built, brought to rated performance, and put into production with a speed and facility utterly impossible for a piston-type engine. Furthermore, the working components of a turbine engine each perform a single function continuously. In a piston engine, by contrast, some parts have to perform several different duties intermittently. It follows that a successful turbine engine can be fairly easily scaled up or down in a manner quite impracticable for a piston engine in which divergent operational characteristics are compromised in a specific design.

Only Two Rotating Components

A turbine jet engine has two main rotating components, the compressor and the turbine, and a combustion system. All three must be of high individual efficiency to produce a successful propulsion unit. In the Derwent Series I, to which these notes refer, a centrifugal compressor is employed not solely because this type had been developed so intensively in the past as a supercharger but because it has wider operating characteristics than the axial type favoured by the Germans. It is cheaper to produce, more robust, of lighter weight, can be run at higher speeds and is not prone to icing.

The choice of a double-sided impeller was made in order to obtain the maximum intake area for a given tip diameter. It must be realised that more than 40 lb. of air (that is more than 500 cu. ft. per second) must flow through the engine and that the compressor determines the necessary diameter of the nacelle on the aircraft. A minor advantage is that forces on each side of the impeller balance out and consequently no special provision for axial thrust is required.

To reach the rear intake the air flows past the diffuser necks and the ends of the combustion chambers. It might be imagined that warming would occur sufficient to impair the efficiency of the compressor. Actually, careful measurement has shown a difference of only 3-4 deg. C. between intake air temperatures at front and rear.

The impeller is a single forging of High Duty Alloy, RR56, with twenty-nine vanes each side. Entry vanes are

integral and bent hot after machining. The impeller at its maximum speed of 16,600 r.p.m. has a tip velocity of approximately 1,500 ft./sec. (This is considerably in excess of sonic speed, which is approximately 1,100ft./sec. at sea level and less at altitude.) From the impeller the air enters a diffuser, and is thence delivered to the ten combustion chambers.

To drive the compressor approximately 100 h.p. is required for each lb. of air delivered per second, or a total of about 4,000 h.p. This power is delivered by the single-stage axial flow turbine. Some idea of the vital importance of the turbine blades will be gained if it is realised that each one has to transmit about 75 h.p., whilst at a temperature of about 850 deg. C. and subjected to the stress of rotation at over 16,000 r.p.m.

The blades alone constitute a considerable engineering achievement. They are fully machined from a special Mond Nickel alloy and in production every one receives a laboratory inspection for dimensions, form and finish. It is of interest to record that, although dimensions have been increased, aerodynamically they are replicas of Air Commodore Whittle's first design.

The "fir tree" type roots of the blades are fitted in slots broached in the periphery of the Jessop G.18B steel turbine disc and peened over on each side of the extremity to retain them axially. Initially, however, they are not rigidly secured in the radial direction but permitted a slight but limited rock at the tip of the blade. In operation, as the metals accommodate the temperatures and loads, the assembly tightens up.

Nozzle Guide Vanes

Before reaching the turbine blade the combustion gases are directed to the appropriate angle of attack by the turbine nozzle guide vanes. The 48 vanes are individual precision castings of a heat-resisting steel and, as cast, are correct to form within 0.0005in., and require no machining but merely a surface polishing. They are cast on the "lost wax" method, reputed to have been invented in the 16th century by the Italian artist Benvenuto Cellini for casting works of art and widely employed in modern times in dentistry. The blades are produced by Rolls-Royce on a modernised system which to a considerable degree mechanises the "lost wax" process.

Rotating components must be most carefully balanced, both statically and dynamically. It is noteworthy that the compressor impeller and the turbine rotor are each dynamically balanced when assembled with their respective shafts. It has been found that balance is likely to be upset if rotors are unbolted and reassembled, and this constitutes an important reason for the division of the drive from turbine to compressor.

The combustion system and the fuel supply and control components were developed in collaboration with Joseph Lucas, Ltd., of Birmingham, which throughout gave the most intimate co-operation and is now largely responsible for the manufacture of these items for Derwent engines.

Early engines, including the Welland, had reverse flow combustion chambers in which air from the compressor entered the forward end of the outer shell of the chamber, and at the rear end made a 180 deg. turn to enter the rear end of the flame tube in which the burner was mounted. Combustion products were ducted from the forward end of the flame tube through the outer shell to the turbine nozzle. The Derwent engines have straight flow combustion chambers, with the burner located at the forward end, and exhaust to the rear. On the reverse flow system the combustion air was preheated but there was a pressure drop due to flow losses and, on balance, the straight flow system yields a somewhat improved combustion efficiency. The reason for the change, however, was primarily due to the altered disposition of the main components. The reverse flow chamber was designed to deliver the air and combustion products to a turbine located as close as was practical to the compressor in order to use the shortest possible shaft connecting the rotating elements. With the use of the divided shaft on the Derwent this consideration no longer applied and the straight flow chamber was adopted. Practical advantages were also gained in the fabrication of the chambers and in reducing the problem of accommodating expansion.

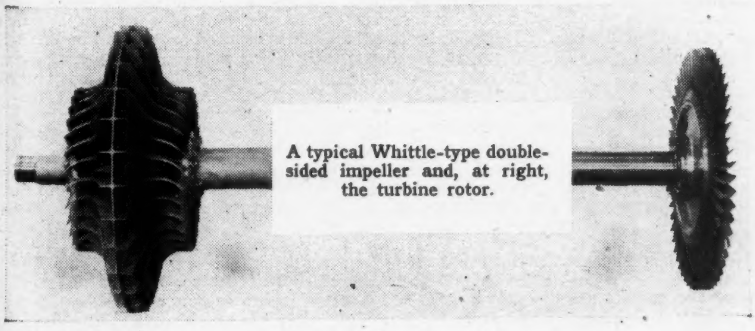
Combustion Chambers

Ten chambers are employed on Derwent I engines, but as few as seven and as many as eleven have been fitted to different types. The choice is not made arbitrarily but as a result of close study of the requirements of a specific design. The aim is to secure the largest total cross-sectional area to obtain a relatively low velocity and the least pressure drop. These factors would be best secured by a small number of large diameter chambers. Practical difficulties, however, prevent this policy being pursued to extremes. A large diameter chamber is more difficult to fabricate, is structurally weaker and presents greater problems in the atomisation and distribution of the fuel. Smooth combustion is likely to be jeopardised and tends to yield a less economical rate of fuel consumption. Another factor affecting the number of chambers assumes an importance if a double-sided compressor is employed. To reach the rear intake, air must flow between the necks leading from the diffuser to the combustion chamber and an adequate area must be maintained or the efficiency of the compressor will be impaired.

As there are no working surfaces in sliding contact and only three main shaft bearings, lubrication presents no insuperable problems even at the high rotational speeds employed. Functioning on the dry sump principle, the total quantity of oil used in the system is only 2¾ gal. carried in a rectangular tank mounted on the wheelcase of the engine. The rate of circulation is about 200 gal./hr. at the cruising rating and 215 gal./hr. as maximum. Built into the tank is a pendulum-actuated device to ensure the maintenance of the supply under negative "G" conditions liable to be encountered during aerobatics.

A triple gear-type pump unit driven at one-fortieth engine speed is mounted on the wheelcase. The lowest unit is the pressure pump delivering approximately 30, 50 and 70 gal./hr. to front, centre and rear bearings respectively and also a supply to the auxiliary gearing in the wheelcase. Pressure at cruising r.p.m. is 35-45 lb./sq. in. Immediately above the pressure pump is the scavenge pump for the centre and rear bearings, and above that the pump scavenging the front bearing and the wheelcase. The combined delivery of the two scavenge pumps is passed through a cylindrical Serck cooler, mounted vertically on the starboard side of the compressor casing, and discharged to the tank. The rate of consumption under all conditions of operation does not exceed one pint per hour.

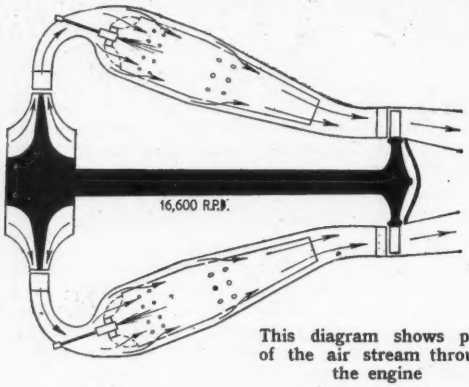
The arrangement of the cooler is ingenious; the air passages being ducted from the upper end to the exterior of the engine nacelle. When the aircraft is stationary on the ground there is a depression inside the nacelle and air flows in from outside the nacelle and passes down through the cooler. In flight, however, ram effect raises the



A typical Whittle-type double-sided impeller and, at right, the turbine rotor.

ROLLS-ROYCE DERWENT

pressure inside the nacelle and air flows upwards through the cooler and is discharged outside the nacelle. An oil cooler is necessary only if plain bearings are employed. Should ball and roller bearings be utilised on later type engines, doubtless the oil cooler will become redundant.



This diagram shows path of the air stream through the engine

The fuel employed is aviation kerosene or, in everyday parlance, paraffin. There are, however, various grades of paraffin, and aviation kerosene is virtually identical with the Pool burning oil (P.B.O.) or illuminating oil used for paraffin lamps. It should not be confused with the paraffin used for farm tractor and marine engines, which is designated tractor vaporising oil (T.V.O.). The jet engine can be operated on fuels ranging from diesel oil to 100-octane petrol without detrimental effect, but the selection of paraffin is dictated by a number of practical considerations. Probably the prime reason, in view of the limited tankage space of fighter aircraft, is the calorific value per gallon. This is considerably higher than 100-octane petrol and if, for instance, after an emergency landing a jet aircraft was refuelled with petrol its operational range would be reduced by about 10 per cent. Diesel oil or gas oil would be better than paraffin in this respect but would bring circulation problems at altitude, as they freeze solid at a temperature of about −5 deg. C.

Due to the scouring character of paraffin good filtration is necessary. Refuelling tankers are equipped with "Streamline" filters, on the engine a "Tecalemit" cloth filter is fitted at the inlet side of the pressure pump and each burner has a gauze strainer. Fuel injection and control equipment is built with very fine working clearances, and to ensure adequate lubrication, one per cent. by volume of engine oil is added to the fuel.

From the aircraft tanks the fuel is fed by an electrically driven immersed pump at a pressure of about 10 lb./sq. in. to the high pressure Lucas pump on the wheelcase. This is of the variable stroke, multi-plunger type driven at one-sixth engine speed and at maximum r.p.m. delivers 420 gal./hr. at a pressure of about 750 lb./sq. in. Delivery is past a barometric device, which automatically regulates the supply to changing altitude conditions, and the pilot's throttle cock to a unit combining an accumulator, a dump valve and a high-pressure shut-off cock. Thence it reaches a common ring manifold and by individual flexible pipes the burners in the combustion chambers. The pilot's throttle is arranged to shut to the idling speed, and to stop the engine the shut-off cock must be used. Operation of this control automatically opens the dump valve, which releases unwanted fuel to atmosphere and prevents flooding of the combustion chambers.

Starting Cycle

Starting is effected by an electric motor mounted on the wheelcase and the cycle is completed in 30 seconds. As the engine is rotated air is driven through the combustion chambers and the fuel pump raises pressure in the delivery line. When fuel pressure reaches 30 lb./sq. in. the spring loading of the accumulator is overcome, and at a pressure of 54 lb./sq. in. the accumulator is fully charged with 5 cu. in. of fuel. At this point a trip valve is actuated and the contents of the accumulator are discharged at the burners. Thus, a sufficiently atomised and ignitable spray is created for about two seconds, enabling the engine to "light-up" with the aid of the two electric igniter plugs located in chambers Nos. 3 and 10. Flame spreads to all chambers by way of the interconnecting pressure balance pipes, and the engine rapidly accelerates to the idling speed. Thereafter it can immediately be brought up to operational rating by means of the throttle cock.

Extensive "warming-up" as required for piston engines, is completely unnecessary. Similarly, no severely regulated operational routine is required. There is no question of a limit of a few minutes on take-off or combat ratings. The throttle can, without any ceremony, be moved over to fully open and the engine kept at maximum rating as long as desired. The only critical factor is the temperature of the gas flow at the turbine. Normally this temperature will not rise above a safe maximum, but it can be kept under observation by a thermometer on the instrument board. Eventually it will actuate a thermally-responsive device which will automatically control the fuel delivery and prevent overheating.

There is no doubt whatsoever that engine builders have taken a giant stride forward. The next move is with the constructors of aircraft for these new rotating power units.

BOOK REVIEW

By Air to Battle: The Official Account of the British Airborne Divisions. H.M. Stationery Office. 1s. net.

EVERYBODY has heard something of the gallant but unsuccessful fight of the airborne troops at Arnhem; but few in this country have very much information about the British Airborne Divisions. Quite probably many people are not at all clear about the distinction between parachute troops and air-landing troops. At last the Government has published a book which tells the whole story.

It starts dramatically, with the astonishment of a Norman innkeeper and his wife when, soon after 1 a.m. on June 6th, 1944, they became aware of black-faced men moving about round their inn. At first they thought they were Germans, and when they discovered that they were British, both burst into tears of joy, and then Mme. Gondrée and her children kissed the nearest soldiers, with the result their faces were immediately covered with black camouflage paint.

But the whole book is not written in this delightful strain. It is a grim and heroic tale, of how men obeyed Kipling's behest to "hold on when there is nothing in you except the will which says to them 'Hold On'" The history of the divisions is recounted, with their training and armament, gliders and tugs, and then a full account is given of the parachute landing in Calabria in February, 1941. That story has never before, we believe, been told in full. It was both a success and a failure; but it showed of what mettle the airborne troops were made.

Then the actions in Africa, Sicily, Normandy, Holland and Germany are recounted in turn and in considerable detail. Naturally, most of the space is devoted to the fighting after the troops had left the aircraft. One is made to realise, however, how very exacting is the part which has to be played by the Royal Air Force, and the difficulties with which it has to contend. Weather, of course, is the most usual difficulty.

Above all, it is instructive to see how the tactics of a landing were developed from the first crude attempt. Arnhem, as we know, was a glorious but bloody failure. The landing east of the Rhine in March, 1945, was a splendid success, though again a sanguinary affair. Its success was due to a complete alteration of tactics since Arnhem. It was made after prolonged battering of the enemy by bombers; was within the range of Montgomery's medium artillery, and was not made until after the Second Army had crossed the Rhine. So our commanders learnt by trial and error. Doubtless there is still more for them to learn.

"Indicator" Discusses Topics of the Day

Economics or Extravagance?

What is Being Done with the Surplus Aircraft and Accessories? : Must We Destroy Real Wealth? : Taking the Easy Road

THE ordinary person can sometimes be forgiven for wondering idly whether those controlling world economy have for long been failing to see the wood for the trees. It is easy enough, I know, to reduce the whole problem to the absolute simplicity of desert-island "communism" and to laugh at the economists who have always made such an extraordinarily complicated matter of an apparently simple affair.

We have all heard *ad nauseam* of the catches of fish that are left to rot or are thrown back into the sea, and of the coffee beans used to stoke locomotives in Brazil while people in other parts of the world are short of food. And we know quite well that, whatever the experts may tell us about market prices and transport costs, such waste is unforgivable and is, figures or no figures, nothing less than the destruction of real wealth. Even if we forget the labours of the living creatures which have produced the crop, both man-power and machine-power were required to grow and harvest, or catch and gut it, and man-power, if only to feed the machines, has itself had to be paid for in food and clothing and services of different kinds. It is, in the end, a plain waste of energy and material.

Now that the war is over we are facing the problem of what is to be done with the surplus of machines required to wage it. On one side we have the manufacturers who are crying for a free, untrammelled market, unburdened with the surplus goods, and on the other we have the people of the world who, whether there is to be a false boom or not, are going to be poorer overall in direct proportion to the amount of otherwise useful material which has been expended while waging war.

Conversions

If we destroy that which can be used, or "lose" it, there will, perhaps, be a more rapid return to normal, but, whatever the economists may say, we must inevitably be exactly so much poorer in the long run. The four or five people on a desert island would, of course, sit back quietly and do no work at all while the surplus machines were available and while no more were required. For some reason which is not immediately clear, such a course is not possible (or permitted) in any more complicated society.

When we deal with aircraft the situation is somewhat clearer, since very few of those built during the war are capable of being converted into suitable and economical civil types, while the operators naturally require the very best and most efficient civil aircraft, as soon as possible, in order to compete with our friends across the Atlantic. The "convertible" aircraft are, presumably, *being* converted to tide over the period during which there is little or no civil aircraft production, and the other obsolescent types are being broken down for various purposes. But what of the accessories?

Some little time ago I was engaged in the business of flying certain ancient bomber types to a field where they were to be broken up and the material used, I believe, for the construction of motor bodies. That part was all right, but when I asked them what they proposed to do with the instruments they merely shrugged their shoulders; "destroyed" was the word they used. When I thought of the price I should have to pay for a single gyro instrument as an "extra" in my light aircraft that I might buy in the distant future, the very thought of destroying such instruments broke my heart.

Now, nobody can tell me that all those instruments were on the point of being unserviceable. A few may have been so, a great many were probably good for thousands of hours, and a few may even have been new or reconditioned replacements installed within the previous month or two. Next year, if I can get one at all, I shall probably have to pay upwards of a hundred pounds for just one of those little instruments. In fact, I shall do without it, and nobody will have gained a brass farthing or will have increased production in the slightest by thus destroying real wealth.

Dealing with Oddments

A few weeks later I learnt on what is usually known as "unimpeachable" authority that radio sets were being dumped in a deep pond (or ponds) which had been chosen carefully so that nobody could possibly fish the things out again, and so that they would be unlikely to appear high and dry during a severe drought before all the items had been satisfactorily destroyed by corrosion. In all probability the sets would be of little use to anybody except the radio amateur, who would undoubtedly have gloated over the hundreds of unobtainable parts which, even when finally purchasable, will probably be much less well made and effective. But I thought of the future and of the frightful price I shall be required to pay even for a light-weight direction-finding receiver when I buy my light aircraft. Obviously, I shall have to forgo such a luxury, and, once again, it will merely have been a case of the wanton destruction of intrinsic wealth—economists or no economists.

It seems to me that there must be a way of dealing with such accessories in a somewhat less blunderingly final way and without spoiling the future market. We have only to think of the two sorrowing members of the community already mentioned—the prospective aircraft owner and the radio amateur—to perceive one possible way out of the difficulty. Why not open a vast "shop" in some suitable place where all such items may be sold for a nominal figure (covering expenses) to individual buyers, not connected with the trade, on a one-visit-only basis and with tokens to allow the purchase of one of each item only? Obviously, it would be possible for unscrupulous buyers to hire a host of "individuals" to make their purchases, but it should not be impossible to combat this strategem, and each of the items could be marked in such a way that they could never be publicly resold. Special dispensations might be permitted in the case of prospective manufacturers of light aircraft and of maintenance concerns, whose use of the instruments and so on would not seriously interfere with the sale of new and improved versions by the accessory manufacturers themselves.

Sensitive Barometer

Obviously, this is not necessarily the most practical and sensible way of getting round the difficulty of disposal—but it is infinitely better than mere destruction. Somehow or other, useful accessories ought to be allowed to reach those members of the public who would not normally be able or willing to buy them even at mass-production prices. Speaking for myself, I should like a sensitive altimeter to use, suitably garnished, as an attractive weather gauge, and, perhaps, a directional gyro to install, in due course, in some private aircraft. But I wouldn't buy either at any commercial price now or later.

I may add that the story about Sunderlands being scuttled in the Irish Sea, each with a hull-full of surplus aircraft magnetos, is untrue. As far as I know, there were no magnetos in any of them. As for the boats themselves, the principle of the fish and the coffee beans applies. What

ECONOMICS OR EXTRAVAGANCE?

would *you* do with a flying boat which you didn't want? Whereas it costs more to ship a landplane out to the middle of the ocean and to hoist it overboard with a derrick than to fly it somewhere and to melt down the structure, getting a flying boat on to dry land, dismantling it, and transporting the bits by road or rail to a suitable manufacturing area is quite a costly business when arranged through the usual channels. Though I've no doubt that a local engineering works, or even a local blacksmith, would have taken the material away quite happily and made some good use of it.

In my profound ignorance of economics and kindred matters, I still suspect that somebody is being too lazy—or, perhaps, is too bound by routine—to think of some original and sensible way of dealing with the whole problem.

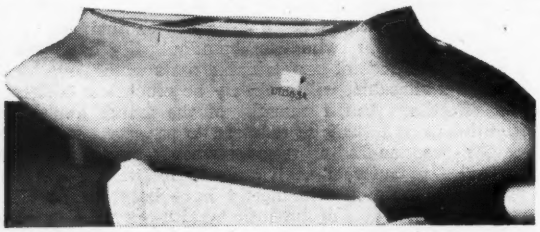
"INDICATOR."

PYTRAM UNDER TEST

THE material from which many of our wartime drop tanks have been made had a unique test during the early part of this year.

Frank Wootton, the eminent R.A.F. war artist, shifted his scene of operations from Europe to the Far East and wanted safe containers for his canvasses. Pytrams made him three capped containers of their ordinary laminated cellulose fibre with walls of 0.125in. thickness.

Wootton was not taking any chances with his pictures. To make sure the canvasses would be safe he tested the tubes by standing them for a while in monsoon flood water; the sort that ruined leatherwear in a matter of weeks. He also filled one of them with damp earth containing several hundred white ants and, by the very nature of the climate, they were often



A Pytram 200-gallon drop tank designed for the long-range Mosquito.

in sunshine until they were much too hot to handle. The only damage that could be detected after three months of this treatment was a small blister on the exterior of one of the containers.

Ordinarily the firm's products do not get such harsh treatment. Their airducts, cowlings, fairings and drop tanks spend a trouble-free existence even under tropical conditions.

The wartime adaptation of Pytram is a masterpiece of British improvisation. From making shop-window articles, artificial bananas and film-studio properties, they turned to such things as Proctor wheel spats, Hamilcar wing tips and a host of other aircraft parts. Each is made of layers of paper built up on plaster moulds and the finished products are light, tough and have a high degree of heat insulation.

PROCTOR FOR PORTUGAL

A VERY cheery gathering assembled on October 18 at Percival Aircraft, Ltd., Luton Airport, to celebrate the first British civil aircraft to be sold as a normal commercial undertaking without Government sponsorship. The purchasers are Daun and Bleck, Ltda., Rua dos Fanqueiros, 263, Lisbon, and the aircraft is to be flown to Lisbon via Paris, Biarritz and Madrid. It really was very pleasant indeed to see this Proctor IV in its shining crimson paint and silver wings, and once more to see registration letters after six years of camouflage and service roundels.

As well as having a useful programme of future aircraft, Percivals have got away to an excellent start by having current orders for Proctors from Chile, Denmark, Sweden, France, Egypt, Palestine, the Lebanon and South Africa.

The Proctor IV is a civilised counterpart of the sturdy wireless trainer and communications Proctor used by the R.A.F., and is probably the most completely equipped small aircraft on sale at the present time; it carries, as standard, full blind flying facilities and is equipped for any suitable type of radio, but radio is not fitted as standard due to the differing requirements in various parts of the world. Price, complete, ex works, is £2,900.

First British civil aircraft to be sold since the war, this Proctor IV will be flying out to Lisbon in a few days' time.

A DAKOTA RETURNS TO SARAWAK

THE first R.A.F. aircraft to land in Sarawak for three and a half years recently restored the link between Britain and the only native State in the world to be ruled by a White Rajah, Sir Charles Vyner Brooke.

The aircraft, a veteran Dakota of the Burma campaign, flew to Kuching, the capital, with a number of Kuching civilians who had been in internment in Singapore for three years or more. In charge of the party was Wing Commander L. N. Reynolds, Commissioner of Police in Sarawak from 1928 to 1939. As R.A.F. Assistant Provost-Marshal he took part in the campaign through Burma. With him was Mr. Wee Kheng Chiang, president and managing director of Chinese banks in Singapore and Sarawak, who at great personal risk smuggled food and money to the starving white internees in Sime Road concentration camp.

The Dakota making this first R.A.F. flight to Sarawak was piloted by Flt. Lt. Norman Currell, of Romford, Essex. As Operations Officer of No. 31 Squadron it has been his job since the squadron reached Rangoon and Singapore to make the first sorties to all Jap-held airstrips where the conditions of runways and the extent of landing and servicing facilities were unknown. At Kuching he made a perfect landing unaided.

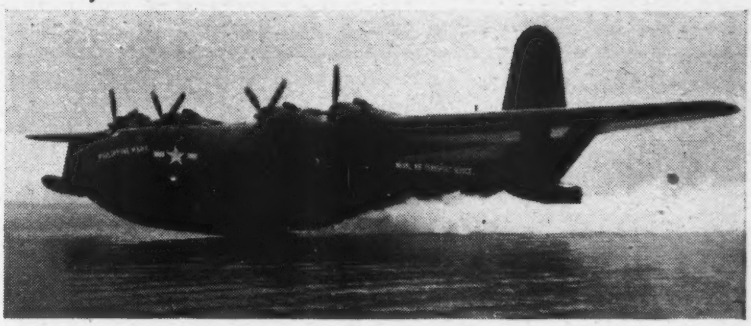
Driving to the city, his passengers found hedges and ditches hidden beneath matted undergrowth ten or twelve feet high. Kitchen gardens, flower beds, tennis courts, all had reverted to the jungle. The golf course looked like a stretch of hilly bush country. The tops of the more imposing headstones in the cemetery were just discernible above the undergrowth, which the Jap prisoners were cutting down and burning. The once neatly painted doors and shutters of the bigger houses hung sideways on broken, rusty hinges.

The people of Kuching had been short of food, and food is still a major problem, particularly as the Japs brought in a large number of Chinese from the Shanghai area. A meal costs a fabulous number of Sarawak dollars. But a yard of Japanese silk can be "bought" for twenty English cigarettes.

"It's taken the Japs only three years of their Greater Asia Co-Prosperity Campaign to do this to what was a veritable paradise," said Wing Commander Reynolds.

"Sarawak was generally acknowledged to be an ideal State, run on model lines with roads, hospitals, lighting and other public services. Everything ran smoothly and efficiently. Now all the amenities and public services established by Sir Charles have been destroyed or taken away by the Japs. My own Oriental collection has disappeared, and the more valuable possessions of most of the Europeans seem to have been dumped in the river if they could not be taken away or used."

CIVIL AVIATION NEWS



THE LATEST MARS : A sister ship to the *Hawaii Mars*, damaged in Chesapeake Bay last August, is the *Philippine Mars* shown here. Note the single fin and rudder.

SIR WILLIAM HILDRED FOR I.A.T.A.?

AT last week's International Air Transport Association meeting Sir William Hildred, D.G.C.A., was offered the post of director-general of the Association for the coming year. If he accepts he will take up his new post on April 1, 1946.

EIRE WANTS AIRCRAFT

IRISH AIR LINES need aircraft to take over the operation of the shuttle service between the Shannon Airport and Britain and to supplement its services on the Dublin-Liverpool route. The former is at present being operated by B.O.A.C. because the Irish company lacks suitable aircraft. Their present fleet includes one Douglas D.C.3 and a D.H. 86. More D.C.3s were asked for, but these are not available, and other markets are being explored.

Mr. J. F. Dempsey, manager of the company, recently left for Montreal with one of the directors of the company to attend the I.A.T.A. meeting, and it is presumed that aircraft purchases will be attempted during the trip.

YET ANOTHER

DESCRIBED as a "little brother" to the Martin 202 described in a recent issue, the 228 is a short-stage 26-passenger civil aircraft of conventional design. The interesting feature is that the wings, undercarriage, tail surfaces, and much of the fuselage structure are interchangeable with those of the 202, so production should be simplified and speeded up, and operators' spare stocks can be reduced to a minimum. The all-up weight is 28,500 lb., as compared with 34,300 lb. of the 202, and the power is provided by Wright Cyclones of 1,425 h.p., against the 202's 2,100 h.p. Pratt and Whitneys.

GETTING UNDER WAY

MORE than a hundred Lockheed Constellations have been ordered by various companies in addition to T.W.A.—for whom the design was originally planned. Unhappily enough, from our own exporting point of view, these purchases include not only U.S. airlines, but R.L.A.F. (Air France), K.N.I.L.M. (Netherlands Indies) and K.L.M., who propose, incidentally, to make Schiphol airfield, Amsterdam, once again their main base of operation.

Whether or not the first series of Constellations will be pressurised remains to be seen. The layouts vary in capacity from 48- to 64-passenger versions, and the aircraft is technically interesting if only because hydraulic control boosters are being used for the first time—at least in a civil aircraft.

AIR FRANCE AGAIN

ON October 22, R.L.A.F.—the present militarised form of Air France—was due to start daily services between Croydon and Paris. Space is being reserved at present for officials, but a fair proportion of seats will be available for non-V.I.P. passengers on a first-come-first-served basis. Douglas DC-3s—or Dakotas—and Bloch 220s will be used.

It is expected that R.L.A.F. will shortly be resuming its old and better-known title of Air France. In the meantime, the company is running a number of European and Colonial services, and one to South America has been planned. Constellations have been ordered by the concern, but whether these or Latécoère boats will be used for the projected South American services is not known. The Latécoère *Lionel de Marmier* was recently damaged at Biscarosse while taking off on a survey flight to Rio de Janeiro, via Port Saint Etienne, in Mauritania.

U.S. AIRWORTHINESS REQUIREMENTS

A DECISION has now been reached by the U.S. Civil Aeronautics Board as far as future airworthiness requirements for transport aircraft are concerned. Although a complete text of these regulations has not yet been issued, an outline of these regulations has been published for the benefit of interested manufacturers.

Some of the more important and worthwhile items are given here, and compliance with the new regulations will be necessary in the case of any prototype flown on or after the first day of 1948.

There is now no limitations on stalling speed, but clear and distinctive stall warning—whether through the aerodynamic qualities of the aircraft or by suitable instrument—shall be made apparent at a speed at least 5 per cent. above the stall. All climb requirements must be met with the cooling flaps set for the hottest conditions, and a minimum rate of climb is set for continuous maximum power. Formulæ have been decided upon for rates of climb with one inoperative engine, and there is a set minimum-climb rate, in the case of four-engined aircraft, when two engines are out while, again, using continuous and not emergency power.

Reversible-pitch airscrews may be used to comply with landing requirements provided that these are normal equipment. Allowance is made for the ability to jettison fuel in the take-off weight requirement figures.

PAN AMERICAN'S ATLANTIC SERVICE

DURING last week-end Pan-American Airways were due to re-establish their North Atlantic air service using, for the moment, Douglas Skymasters. Last month the company made a survey flight with a Skymaster from New York to Gander (Newfoundland), Rineanna, Hurn and Bovington, Hertfordshire. At the moment of writing P.A.A. are waiting for a decision from the Ministry of Civil Aviation concerning the use of a suitable airfield in the London area. They are hoping to be able to make either Northolt or Bovington their temporary terminal, but if no decision has been reached in time the Skymasters will proceed from Rineanna to Hurn, Bournemouth.

The fares which have been announced are extraordinarily low—£69 single and £124 return—and a very great deal lower than those charged by B.O.A.C. on their summer service with Boeing Clippers. At the same time, it should be pointed out that these fares are also lower than those charged by P.A.A. when they were using the more expensive flying boats. The company made a promise of fare reduction when the landplanes were put into service, and it is probable that a further reduction will be made when Constellations are used—always provided, of course, that arrangements can be made for an adequate number of services to give a high "utilisation" figure. Pan-American Airways are themselves satisfied that the new fares can be economic with good service frequency. For a start, the service will be operated twice a week.

EXPORT AIRLINES, TOO

AT about the same time—on Tuesday of this week—American Export Airlines were also due to start an Atlantic service using the same type of aircraft. Previously, American Export had been using Sikorsky S-44 flying boats, and the last service with this type was due to leave New York on October 20. This company started North Atlantic operations in June, 1942, and have operated services across the South Atlantic between Africa and South America as well as running a fleet of boats for the U.S. Naval Air Transport Service. In July this year American Airlines were permitted to acquire the control of American Export, the name of which may shortly be changed.

HERE AND THERE

Mightier than the Sword

AMILES Aerovan flew to Zurich, Switzerland, last week carrying a load of 5,000 fountain pens. It called at Le Bourget to clear customs and at Dijon, and is to give demonstration flights in Switzerland and France.

The Last Wimpey—

THE last Wellington bomber to be made in this country—a Mark X—went through its test flights at Squires Gate, Blackpool, recently, after which the Mayor and Mayoress and members of the town's corporation were given flights in it.

A luncheon followed, at which a stainless steel model of the Wimpey was presented to the Mayor of Blackpool by Vickers-Armstrongs who have built a total of 11,461 of these famous bombers.

—and the Last Halifax

THE last of the Fairey-built Halifax bombers—the 661st—recently left the production line at the Government factory at Errwood Park, Stockport.

Production of the Halifax was begun at this plant in October, 1942, under the dispersal scheme, and in 18 months reached a monthly output of 34 aircraft.

Employing about 7,000 at the peak period, of whom less than 4 per cent. were skilled labour and 40 per cent. were women, the factory is to switch to civil production under the Board of Trade.

College of Aeronautics

PROVISION for the preliminary expenses of the College of Aeronautics has been made in the supplementary estimate for education. Miss Ellen Wilkinson, Minister of Education, mentioned this when replying to a debate in the House last week on a vote of £4,168,000 for her Ministry.

"Arrangements have been made with the Air Ministry," she added, "to accommodate the college temporarily—so that a start can be made early next year—at Cranfield. There will be residential, teaching, and flying facilities."

Thank You, Sir Richard

MEMBERS of the Press have particular reason to appreciate the qualities of Air Marshal Sir Richard Peck who has just retired from the R.A.F. after being Assistant Chief of Air Staff since February, 1940.

Nobody could have conducted the Press conferences at the Air Ministry with greater tact and courtesy than did Sir Richard, for no matter how many awkward questions were fired at him (and Pressmen *can* think up the most searching kind!) he was never disconcerted, but preserved a genial diplomacy that won everybody's liking and respect. Best of all he paid the Press the compliment of entrusting them, on many occasions, with helpful "background information" and, needless to say, this confidence was always respected.

At present Sir Richard is enjoying a well-merited rest, but we sincerely hope that British aviation will not lose the valuable services of a man of such wide experience and pleasing personality.

Lord Portal Also Retires

MARSHAL of the R.A.F., Lord Portal of Hungerford, who began his Service career as a despatch rider in August, 1914, and has been Chief of the Air Staff and Senior R.A.F. Member of the Air Council since Ocober, 1940, is to retire on January 1st, 1946.

Lord Portal has rarely been in the limelight, although he may fairly be described as one of the main architects of victory. He was one of Mr. Winston Churchill's chief advisors at the various great war conferences. He was made G.C.B. in June, 1942, and a Baron last August.

He will be succeeded by Marshal of the R.A.F., Sir Arthur Tedder.

Changes at Avro

WITH the retirement from active flying duties of Capt. H. A. Brown, who is at present in South America on the firm's behalf, Mr. S. A. Thorn has been appointed chief test pilot of A. V. Roe and Co., Ltd. Capt. Brown now takes up a post on the administrative side of the business.

"Bill" Thorn, who joined Avro's in 1934 as a test pilot, has worked with Capt. Brown on all special test work, and it was he who took the Tudor I into the air for the first time on June 14th last, and since then has put it through exhaustive flight trials.

Air Marshal Sir Richard Peck.

Mr. T. G. Green, who has been inspector-in-charge at the Avro group in the Manchester area since January, 1940, also retires after 30 years' service in A.I.D.

Good Samaritans

AUSTRALIAN Dakota aircrews, ground staff, nursing sisters and medical orderlies in Singapore recently withdrew their applications for repatriation so that they might fly sick prisoners of war from the East Indies to hospitals and rest centres, and their unselfish service earned a special commendation from Lord Louis Mountbatten, Supreme Allied Commander.

"I am certain your action saved very many lives," he told them.

Deaths in Sumatra camps were averaging six or seven a day, and it was to check this heavy toll that the R.A.A.F. men and nurses flew something like 300,000 miles and, in just under four weeks, carried 1,000,000 lb. of urgent supplies to the prison camps and evacuated 1,200 to Australia.

During the present year, the R.A.A.F. transports have flown in 26,600 reinforcements.

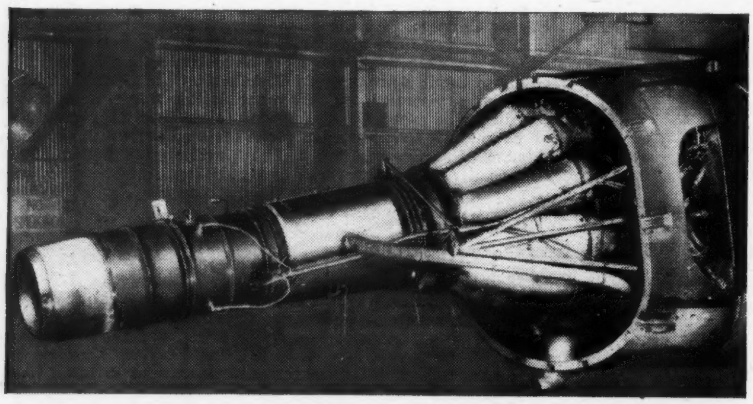
"Personal" Aircraft

SOME indication of what is to happen to R.A.F. surplus aircraft may be given within the next few weeks, but anyone who has notions of picking up a fighter for personal use ought to ponder the experience of Mr. Arthur D. Knapp, of Jackson, Michigan.

He is the first known civilian buyer of a P.38J. Lightning, the machine that a sceptical American journalist once described as "too much ship for one man to fly and fight."

Mr. Knapp collected his Lightning at Bush Field, Georgia, and flew to Stout Field, Indiana, at an average speed of 301 m.p.h.—and an operating cost estimated at about £15 an hour. And when he stepped down at Stout Field in civilian clothes he was promptly arrested.

It took some time, and production of



FLYING TEST BED : In order to carry out altitude tests during the development work on the Rolls-Royce Derwent jet engine, a unit was installed in the tail of a Wellington bomber in place of the gun turret, as depicted here. The Wimpey carried the usual test-recording gear and flew normally on its own engines.

HERE AND THERE

official proof of ownership, to persuade the guards that he was an ordinary civil pilot flying his own aircraft.

Radio-controlled Combat

A RECENT news item issued by the U.S. Navy mentions the development of "a pilotless radio-controlled fighting plane" believed (it is said) to be the only one of its kind in the world.

This aircraft takes off under the control of a pilot sitting in a lorry after which another pilot in a "mother" aircraft takes over and guides the "ghost plane" on its mission and back to its base where the pilot on the ground effects the landing.

Precisely what function this radio-controlled "fighting plane" is intended to fulfil is not stated, but it would seem that the radio control would have to go further than merely flying the aircraft; it would, presumably, have to operate its offensive and/or defensive armament, or perhaps release bombs.

PIN-POINTERS: This close-up of the R.P. Spitfire XIV shows the "zero length" launching equipment which succeeds the old rails under the wing. The rockets are slung in pairs and can be fired separately or in a salvo.

News in Brief

IT is expected that all R.C.A.F. personnel except those required for the occupation air force will have been taken home by the end of March next. More than 36,000 of them have been repatriated since May 1st this year.

* * *

It is proposed to hold a Squadron reunion for members of No. 38 Squadron early in the New Year. All members who served with this Squadron from October, 1940, to July, 1942, and who wish to attend should communicate with Sqn. Ldr. A. Price, R.A.F., St. Vincents, Grantham.

* * *

The Isle of Wight branch of the R.Ae.S. held its first lecture of the present season last Tuesday at Saunders Sports and Social Club, East Cowes. It was given by the president of the branch, Mr. A. Gouge, on the subject of "Flying Boats; their Development and Possibilities."

* * *

A paper entitled "The Fabrication of Aircraft Fuel Tanks in Aluminium Alloy containing 3 per cent. Magnesium" has won for Mr. W. K. B. Marshall the Sir William J. Larke Medal for 1945 and a first prize of £50, awarded by the Institute of Welding.

* * *

Sir Alexander Fleming, famous for his work on penicillin research, has been visiting R.A.F. and other Service hospitals in the Mediterranean theatre under the guidance of Air Vice-Marshal T. J. Kelly, the R.A.F.'s chief medical officer there. While in Italy he was the guest of Air Marshal Sir Guy Garrod, C.-in-C. R.A.F. Mediterranean and Middle East.

* * *

A representative body of manufacturers in the paint industry has recently formed the Society of British Paint Manufacturers, Ltd., with offices at Amberley House, Norfolk Street, Strand, London, W.C.2. Its principal object is to raise the status of the industry and to deal with the problems of transfer from war to peace and future development. Founder members of the society are estimated to employ 8,500 people and to represent a widely spread public investment amounting to £19,000,000.

* * *

An extraordinary general meeting is being called for 11 a.m. on Sunday, December 2nd, by the Society of Model Aeronautical Engineers to discuss contest rules and formulæ. The meeting will be held at the Waldorf Hotel, Aldwych, London, W.C.2.

* * *

A meeting in Galway (Eire), under the chairmanship of Mr. John O'Donnell, a local solicitor, has decided to form the Galway Flying Club. Until facilities for flying training are available in the district the club's activities will be confined to a series of lectures on aviation during the winter months.

* * *

The death is announced of Mr. R. H. Comley, joint managing director of the Avon India Rubber Co., Ltd., and this year's president of the Federation of British Rubber and Allied Manufacturers' Association, on October 13th after a short illness. He began his business life in 1906 with a concern which was later absorbed by Avon, and was a well known figure in the industry.

* * *

Mr. W. T. W. Ballantyne, who has been in aviation since 1915 and whose experience embraces that of pilot, engineer, and sales executive, has gone to Rio de Janeiro as the first British "trade ambassador" under the ægis of the export section of the S.B.A.C. His headquarters will be in the Brazilian capital, but his activities will extend to all Latin America, where there is an extensive potential market for British aircraft.

* * *

Power Laundry, which was established in 1903 and is the leading journal of the laundry, dyeing and cleaning industries, has been bought by The Associated Iliffe Press Ltd. from The Hulton Press Ltd., and will be published fortnightly by The Trader Publishing Co., Ltd., one of the Iliffe subsidiaries.

A new branch has been opened in Northern Ireland by Wellworthy Piston Rings, Ltd., at 67, Chichewter Street, Belfast. (Tel.: Belfast 23160.)

* * *

Mr. A. J. Lowe, London manager for Thompson Brothers (Bilston), Ltd., has now reopened the London office at Aldwych House, W.C.2. 'Phone: Holborn 1416.

* * *

Hunting Aero Surveys, Ltd., have moved from their temporary address in St. James's Street to a permanent office at 29, Old Bond Street, London, W.1, and are only awaiting the lifting of the ban on civilian flying and photography before resuming operations.

* * *

Mr. H. A. Francis, A.F.C., M.A., F.R.Ae.S., who went to Australia in 1939 to join the Commonwealth Aircraft Corporation Pty., Ltd., is now on a visit to Britain for technical investigations on behalf of his firm.

* * *

In the pictorial feature, "Some Recent Releases," in *Flight*, October 18th, the initial numeral was accidentally omitted from the weight of the Firebrand's torpedo. This should have read 1,850 lb.

* * *

Mr. A. G. Wilson, who up to recently represented Henry Rossell & Co., Ltd., in the West Riding of Yorkshire and the West of England, has relinquished the latter area and will in future cover the West Riding and the north-east coast area. Mr. Wilson has been with this company for more than 30 years.

* * *

Brigadier Arthur Lovesley has been appointed general manager of the Edgar Allen Steel Foundry and ancillary departments. Brigadier Lovesley was with Edgar Allen and Co., Ltd., from 1910 until 1928, when he left to join another firm. He served with distinction in both wars as soldier and engineer and, when the R.E.M.E. was inaugurated, was appointed its chief.

Boscombe Down Entertains

The Aircraft Industry Sees its Products in Action, but Against Targets in Peaceful Wiltshire

SALISBURY PLAIN saw most of the early struggles of British military aviation to establish itself as a serious fighting arm. Upavon, Netheravon, Lark Hill are names which are for ever linked with the early flying days. Recently Wiltshire was once again the scene of air aggressiveness, and those old enough to have shared the tribulations of the days when it was difficult to get an aircraft to fly, let alone carry any appreciable military load, must have been immensely impressed by the tremendous development which lies between 1912 and 1945.

The Military Trials of 1912, or to give them their official designation, the Army Aeroplane Competitions, were won by S. F. Cody on a pusher biplane of 430 sq. ft. wing area powered by a 120 h.p. Austro-Daimler six-cylinder water-cooled engine. The weight of the machine empty was 1,948 lb., and fully loaded 2,680 lb. Wing and power loadings were 5.55 lb./sq. ft. and 23.8 lb./h.p. respectively. The minimum speed was 48.5 m.p.h., and the maximum 72.4 m.p.h. The modern generation will smile at these figures, but that was the sort of background against which the present-day R.A.F. must be viewed if one would appreciate how far we have come since 1912. Cody carried off the first prize of £4,000 open to all comers (the competition was international) and a further prize of £1,000 open to British subjects and aircraft built entirely (with the exception of the engine) in the United Kingdom.

It should be explained that aircraft were, in 1912, regarded by the authorities as merely of possible and somewhat doubtful value for reconnaissance. The question of arming them had not arisen except that possibly some of the more far-seeing Army officers, such as Sir Arthur Henderson, may have visualised them carrying rifles.

The recent two-day demonstrations were given by the Aircraft and Armament Experimental Establishment, at which all new types are given their official tests, and the guests were mainly technicians from the aircraft industry, with a sprinkling of officers from the Services. The idea was to let the industry see all the latest armament for which their aircraft are designed, and much equipment which is still secret was on view and shown in action. The demonstrations were divided into two distinct sections. On the first day the guests inspected armament on the ground and on test in the firing butts. The second day was devoted to a flying display at which all the various forms of weapons were demonstrated in action against different targets.

Closer Collaboration

We do not know what was the main official object of the demonstration, but the effect on us was that there is need for even closer collaboration between the armament people and the aircraft people. Thus in future, aircraft design may and should be a joint affair between a triumvirate of airframe, engine and armament specialists. It already is to a considerable extent, but the knitting-together must be even closer in future.

"Show Everything" appears to have been the motto of the static exhibition, as will be gathered from the fact that it included everything from sectioned bullets to the

An eight-gun Hurricane demonstrates the effect of incendiary bullets fired at aircraft on the ground.

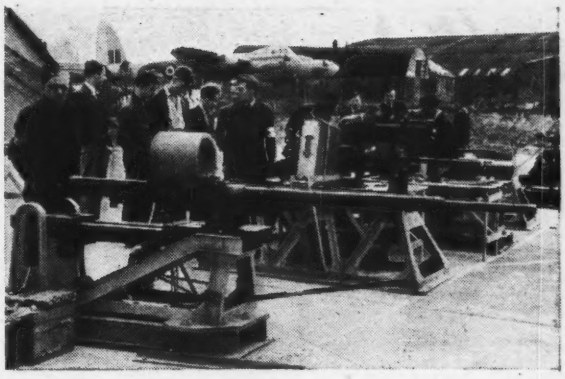
BOSCOMBE DOWN ENTERTAINS

22,000-lb. bomb, from the 0.303 machine gun to the 6-pounder fired from Mosquitoes, from types of power-operated gun turrets of which the public has not been permitted to know anything to firing demonstrations in the butts, from the earliest to the latest rocket-propelled projectiles, and from combat films to the most amazing series of "before and after" photographs of bombed enemy targets.

Rocketry formed a large part of the demonstration, and it is unfortunate that so much of the matter exhibited cannot be published. This form of offensive armament has been developed to an astounding degree, and in general it can be accepted that the chief factors determining any rocket-equipped aircraft's limitations of fire power are the weight of rockets it can carry, and the drag and installed weight increases it can afford. Looking into the future, it is not too much to expect that we may see the machine guns and cannon of to-day displaced by rocket-guns firing self-propelling shells with great accuracy for extreme ranges and at high rates of fire. This, too, without the heavy vibratory loadings on the airframe which make the present designers' job so much more difficult.

Bombs and More Bombs

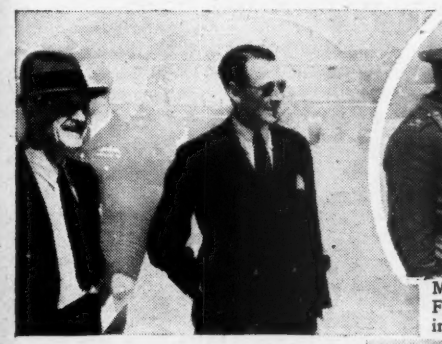
Bombs are not quite so flexible as rockets, and although of almost infinite variety in size, type and use, are nevertheless still missiles which have to be carried to the target and dropped by means of some form of instrumentation. Under the general heading of "bombs" comes everything from the tiny 1¼ lb. incendiary to the mighty 22,000 lb. "Grand Slam," and in this aggregation are high capacity bombs, medium capacity bombs, general purpose bombs, fragmentation bombs, anti-submarine bombs and depth charges, incendiaries, mines, cluster projectiles, target indicators, and smoke bombs. With these are an equally large variety of fusings, variants of which are also employed in the numerous types of rocket projectiles.



From 40 mm. upwards. An array of automatic aircraft weapons at the stop butts.

Not the least interesting aspect of aircraft guns is that concerned with performance and functioning. It was realised many years ago that the problem of testing armament installations in aircraft would become so complex that a scientific approach would be necessary, and the appropriate departments of the A. and A.E.E., therefore, got busy and evolved a whole series of devices whereby the behaviour of a gun could be recorded whilst operating in a variety of diverse conditions. These devices include kinematic recorders of the mechanical, photographic and electronic type, together with strain gauges whereby mounting loads can be measured, and recorders of various types for registering rate of fire. In addition to these are special pyro-

(Below) Grp. Capt. P. W. S. Bulman and Mr. C. Turner-Hughes, A.-W. chief test pilot, seem amused at other pilots' efforts.



Major-Gen. Jefferies, Air Comdre. Franks and Air Comdre. Mellersh inspect the armament of the Meteor.

Grp. Capt. Ford and Mr. J. D. North watching the performance of a Boulton-Paul gun turret.

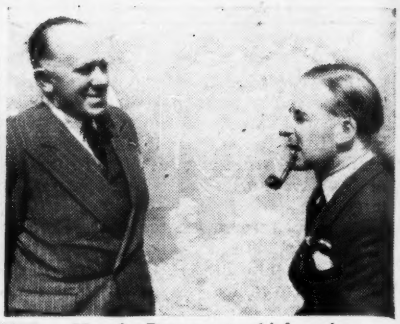
Mr. Geoffrey Smith, with two "Glostrians," Mr. Eric Greenwood, chief test pilot, and Mr. F. McKenna, managing director.

Three Hestonians: Messrs. Jones, Cornwall and Lingham.

Mr. Shirvall, project engineer, and Mr. Quill, chief test pilot, Supermarine.

Air Vice-Marshal J. N. Boothman, Asst. C.A.S., with Mr. Summers, Vickers chief test pilot.

Capt. A. Frazer-Nash and Mr. L. Motley debate "turretry."



Mr. A. Davenport, chief engineer, and Mr. H. Penrose, chief test pilot of Westlands.

Air Comdre. Patch and Air Vice-Marshal Combe, Director-General of Armament.

Sir Geoffrey de Havilland is pleased with Flt.-Lt. Zurakowski's demonstration of the Vampire.

Col. Miles and Capt. Bayliss are interested in the display of the Invader.

meters to check the requirements of gun heating and cooling in order to ensure that optimum fire efficiencies are attained.

Assessing Efficiency

It is not generally realised among those outside the technical fields that by far the greater measure of man's effort in putting a weapon into effect is taken up with the creation of measuring and checking devices with which to assess the weapon's efficiency and to maintain and enhance that efficiency. Very often a single measuring device will be far more complicated than the object it assesses, and in probably no other field is this so well demonstrated as that of aircraft armament. We have mentioned a few of the devices used for guns, but there are many more dealing with other branches, and to give a brief list of these will help the reader to get a better overall picture of the intensive work that has been, and is being, done.

For example, there is the photoflash-functioning recorder, which investigates and evaluates the distribution of flash intensity for air functioned photoflashes by means of photo-electric cells and cathode-ray oscilloscopes, range being assessed by computation from the time interval between flash and detonation. Then there are the recorders which measure by mechanical or electronic means the highly critical time lag of bomb-release slips. Further, there are devices for measuring time interval in the release order of bombs, and also automatic observers employing discharge lamps to register spacient time and order during stick releases.

To these must be added a whole list of other equipment for measuring and recording such things as conditions before, at the instant of, and after release of bombs; for recording aircraft attitude, side slip, and acceleration during rocket discharges; for investigations of rocket behaviour during initial stages of its flight; for measuring rocket velocity off the launching rails and the time interval between firing and leaving the rail.

Having seen this incredible host of equipment, one is advised by the loudspeaker broadcast system that the six-pounder gun fitted to the Mosquito (in this version named the Tsetse) is to be fired into the stop butts. One walks across and, being told that firing is about to begin, puts one's fingers to one's ears. There are spasmodic licks of flame and the Tsetse rocks and jumps against its lashings, the smoking cases clang down on to the concrete and gouts of sand spurt from the interior of the butt. When it is all over, one takes one's fingers from one's ears and smiles at one's neighbour. It is a horribly impressive performance, and then, whilst walking away, the thought comes to the mind that, with everything else in the exhibition, one has seen the very pinnacle of contemporary achievement in scientific methods for killing one's fellow men—before they kill you.

All shapes and sizes. A varied assortment of bombs, up to 22,000 lb., at the static display.

Of all the events in the flying programme of the second day of the demonstration, the one which most impressed the spectators was, curiously

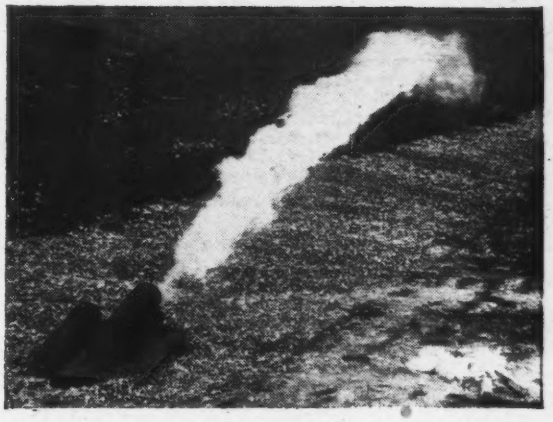
enough, not a flying display at all but the firing of rocket projectiles of various types and sizes from the ground. That this demonstration was so impressive, not to say terrifying, was due to the fact that the projectiles were fired along a line parallel with the spectators' enclosure. Consequently the tearing, rending sound from the rocket motors was very clearly heard. In actual warfare, the recipients would not, of course, be in that position relative to the projectiles, but, nevertheless, experience has shown that the moral effect of rocket projectiles is very high indeed. Many a time during attacks on enemy tanks the tank crews have been seen to rush out precipitately and throw themselves flat in whatever shallow depression could be found, rather than to stay inside the tank and take advantage of what protection its armour afforded.

Low Angles of Attack

Accuracy of rocket projectiles does not yet appear to be of a very high order, more especially when the trajectory is very flat, such as when the projectiles are fired from low-flying aircraft or from a ground base. This is easily understandable when one realises that a difference of a degree or two in elevation means, at that flat angle, quite a considerable distance along the ground. This fact was brought out very clearly by the attacks made by low-flying aircraft on ground targets. Relatively few hits were scored. When, later in the programme, attacks with rocket projectiles were made from a greater height, viz., from aircraft in a dive, the pilot of a Spitfire scored direct hits with his very first salvo, the target (in this case a tank) being of very little use to anyone afterwards, including his fellow attackers.

Whether an attack is made from low level or from a dive will, of course, depend upon the nature of the target. The low-level attack is by no means useless even if the accuracy is still not very great. For a target extending a considerable distance in depth, for instance, the spreading in the fore-and-aft direction (from the aircraft point of view) is not necessarily a serious drawback. Objectives in the near edge of the target area may be missed, but

The Naval Air Service is interested in cluster bombs and obviously absorbing a lot of "Gen."



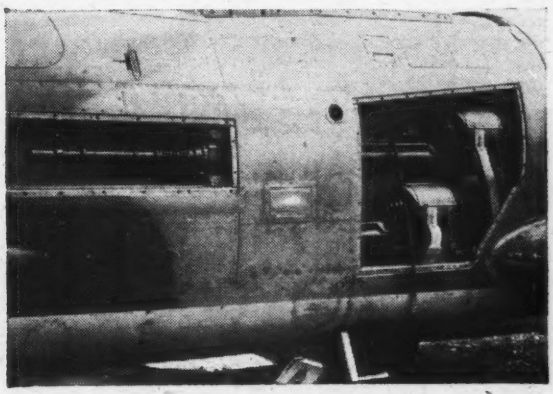
A demonstration of the 15ft. flame thrown out by the 30-lb. petrol gel incendiary bomb.

there is a very good chance of hitting another farther back. Rocket projectiles are still in their infancy, and it would be rash to attempt to forecast their future, both as aircraft-borne weapons and as ground-mounted offensive and defensive "guns." From the aircraft designer's point of view, they have the tremendous advantage that there is no recoil to stress the aircraft structure. That fact in itself appears to point to a very extensive use of rocket-propelled shells.

A "Hail of Bullets"

Not that the quick-firing types of gun will not have their uses. The spectators at the demonstration had forcibly brought home to them the fact that "a hail of bullets" means something. To see the streaks of 0.303, 0.5, 20 mm. and 40 mm. projectiles going towards the targets and striking like hail pattering on a roof gave a very good idea of what it must be like to be on the "receiving end." At the other end of the scale was the demonstration by a Mosquito of the firing of 6-lb. shells at a target of aircraft on the ground. At the first attempt something went wrong, apparently both with the gun and with the aircraft's radio, for no sheet of flame showed the gun had been fired and no explosion, or even cloud of dust, gave any indication that the projectile had landed anywhere. Later the Mosquito did its firing out of its turn in the programme, but the targets (aircraft on the ground) were still fit for service after the runs. The pilot, fortunately, had a sense of humour, and his laughter could be heard on the loudspeakers after each miss.

Of bombing demonstrations there were many, the types of aircraft including such single-engined types as the Fire-



Twin 20 mm. Hispano cannon on the port side of the Gloster Meteor jet fighter.

BOSCOMBE DOWN ENTERTAINS

fly, Typhoon, and Tempest, and four-engined machines like the Halifax, Lancaster and Lincoln. In the main they were not terribly exciting except for the dropping of a 12,000-lb. bomb by a Lancaster III. Many Londoners had an opportunity, during the attacks on London, to see the shock wave from the flying bombs. The one from the 12,000-pounder was worth seeing as it appeared to crawl like a wave of irregular formation down the hillside. The "bang" itself was, of course, very convincing and made one realise what German cities had to "take." It was noticed that the bomb "hunted" slightly on its way down (it had a somewhat undulating trajectory).

Incendiarism was well represented, but the clear weather made the effect less pronounced than it would have been on a dull day, a sacrifice which the guests were not sorry to make in favour of some of the other displays. Even some of the really heavy incendiary bombs failed to convey an impression of the trouble which they caused the enemy, although doubtless the birds from which the hill of the demonstration is named could tell a different tale.

Turrets had been a prominent part of the previous day's static display, and in the flying demonstration an Avro Lincoln was used for showing three types of turret in operation. It was the gunner of the mid-upper (a Bristol turret) who aroused the admiration of the spectators by his marksmanship with two 20 mm. guns.

Amidst the demonstrations of the work of the R.A.F. Fighter, Bomber and Coastal Commands, the Naval Air Service was not overlooked. A Fairey Barracuda dropped a stick of mines, the parachutes of which appeared somewhat small for their work. This fact, however, doubtless improves the accuracy of the minelaying. A dive attack by a Firefly dropping two 1,000-lb. bombs was stated to be carried out at a speed of 350 knots.

The Two Extremes

An "ancient and modern" atmosphere was introduced by fly-pasts of some of our slowest and some of our fastest aircraft types. Among the former was a Swordfish, which fired its solitary 0.303 free gun against a ground target. A Supermarine Sea Otter amphibian sailed past most stately, and an Avro Tutor brought back to many memories of their days at the flying schools. A Fieseler Storch was added to lend a comic touch, and the pilot of a Gloster Gladiator gave a fine display of aerobatics, manœuvrability rather than speed being the long suit of this machine, whose heroic work at Malta will ever be remembered.

Many wonderful examples of the "modern generation" took part in the next fly-past. The Gloster Meteor I jet-propelled fighter and the new de Havilland Hornet twin-engined fighter did a fine bit of formation flying, afterwards firing at a ground target with 20 mm. cannon.

A little light relief was provided by the slow-flying demonstration of a Fieseler Storch.

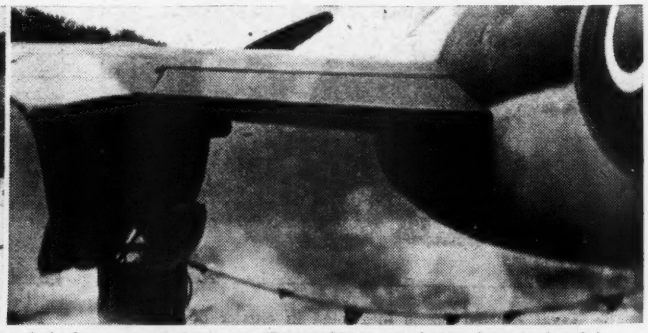
It was scarcely fair to the Gloster company to put this, by now, outmoded jet fighter into the programme, and from mere visual observation one would say that it was no faster than the Hornet, which promises to be another really outstanding type from the de Havilland firm. A Westland Welkin made an unexpected appearance, its large span and high aspect ratio giving it a distinctive appearance.

Unfamiliar names such as Brigand, Spiteful and Sea Fury appeared on the programme in this item, but if we said anything about them the Censor would cut it out, so we refrain, except to say that they look promising.

The *pièce de résistance* so far as actual flying displays were concerned was undoubtedly that given by Flt. Lt. Zurakowski on the de Havilland Vampire jet-propelled fighter. He first flew past at what appeared a dangerously low speed, and most knowledgeable folk drew a sigh of relief when he opened his throttles and, somewhat tardily, the pressure built up sufficiently to give the desired "urge."

That there was plenty of this urge in the de Havilland jet units was amply demonstrated afterwards, when Flt. Lt. Zurakowski did some terrific dives and zooms, following the latter by vertical rolls terminating in half-loops, half-rolls, full loops, etc., which carried the machine almost out of sight. His horizontal fly-pasts at speed brought back memories of the once-famous Shell slogan, "That is a Vampire, that was."

Altogether the two days in Wiltshire formed a very pleasant and instructive interlude in the day-to-day routine work of the aircraft industry, and all were grateful to the C.O. of the A. and A.E.E. One could not help reflecting what a pity it was that such a show could be held at Hendon for the benefit of the general public. It would have made the old R.A.F. Displays look rather tame, but modern aircraft, not to mention the various "bangers," do not lend themselves to the narrow confines of Hendon.



(Left) The six-pounder Tsetse will now fire. Visitors put their fingers to their ears. (Right) Close-up of the six-pounder firing.

CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

CAMPAIGN AWARDS

Rank Distinction Should be Abolished

I DO not wish to add to the already voluminous correspondence that has appeared on the subject of Campaign Medals, but I do feel that it is time that rank distinction as a governing factor in the award of decorations was abolished. Surely it is both ridiculous and invidious that a Flight Sgt. Pilot and Captain of Aircraft should be awarded a D.F.M. and his Pilot Officer A/G. a D.F.C. This might well happen and probably has happened under existing regulations. The same, of course, applies to other decorations where distinction is based on rank and not merit, *e.g.*, A.F.C., A.F.M.; M.C., M.M.; and so on. After all, the Victoria Cross can be won by other rank and officer alike; why discriminate in lesser decorations?

JOHN BENNETT.

FOR THE OWNER-PILOT

Plea for a Safe Low-powered Single-seater

I READ with interest your articles on the future of civil flying for the private owner.

I see that the Auster does about 20 miles per gallon taking three persons, therefore costing about the same to run (excluding maintenance) as a 20 h.p. car; but I see no mention of what is in store for the single man, who now runs a motor cycle or light car. He won't want an Auster or something that only does 20 m.p.g. He will want, however, something that will take just himself and a small suitcase about the country at week-ends doing 45-60 m.p.g., and also be capable of landing and taking off from small fields.

Before the war several aircraft were built powered by motor cycle engines, so surely a single-seat aircraft, built on the tailless layout perhaps, with, say, a horizontally opposed twin of about 500 c.c., would be the answer to his problem. With slots and other devices the machine could be made almost foolproof from the stalling and spinning point of view.

To finish, I would say that with the last six years of development surely something could be done (cheaply, I should imagine) to get 200 lb. of man and baggage off the ground on as little power as possible and with the shortest landing and take-off runs.

T. F. FEUERHEERD.

BOMBERS OR ROCKETS?

Problem of Dissipating Heat

REFERRING to the article "Bombers or Rockets," by A. V. Cleaver, appearing in your September 6th issue, I should like to point out that any increase in the exhaust velocity of a propellant means an increase in heat, and this stands for any sort of propellant, whether atomic-powered or not. The only known exception is compressed gas; its exhaust velocity, however, is not quite the thing for a rocket.

As a matter of fact, even a tenfold increase in exhaust velocity implies a hundredfold increase in heat generated per kg. of fuel and a tenfold increase in heat generated per kg. thrust.

Thrust, however, has a minimum value, below which the rocket would not leave the ground at all. This value is the starting weight of the rocket. A limit exhaust velocity therefore exists, above which the heat generated per pound of thrust grows too big, the temperature in the combustion chamber too high, and the propellant too hot to handle.

To quote a concrete example: the heat generated by the 36lb. of atomic propellant mentioned in A. V. Cleaver's article as having 335 times the exhaust velocity of an ordinary explosive (cordite) works out at 1,820,000,000 calories. This about as much as the equivalent of 3,000,000 horse-power-hours, and enough to vaporise 3,000 tons of water. If it could be spread over a couple of hundred hours, things might be arranged, but the rate of burning or rate of mass flow has to be kept high enough to provide a thrust superior to the starting weight of the rocket, and in the case of a V2 it works out at more than 4 tons.

This necessitates a rate of flow of 0.056 kg./sec., and the heat generated per second is at least 6,350,000 cal. The heat per kg. thrust works out at about 1,585 cal. If an upward acceleration of I.G. is required, the figure must be doubled. Should even 3 per cent. of six million calories pass into the combustion chamber walls, the heat would be enough to melt a ton of steel. No cooling system could be devised to take even this amount of heat away in a second and keep the outside of the combustion chamber at less than 1,000 degrees C. The inside temperatures might easily reach solar values.

Even a propellant with only five times the exhaust velocity of an alcohol-oxygen mixture (five times 2,500 = 12,500 m./sec.) would be about as easy to handle as an engine giving 2,500 h.p. per litre.

All this does not preclude the use of high-power propellant in space, when the question of starting against gravity no longer counts, and the propellant can be spread over weeks and fired off in intermittent shots. The cooling problem then becomes that of a gun fired in a vacuum. But to reach escape velocity, or even orbital velocity (8,000 m./sec.) only low-power propellants can be used and the mass ratio must remain high, as long as the rocket has to start from the ground.

Orbital velocity could, however, be reached by using a compressorless, jet-propelling plant, of the simple diffuser type, such as described in your paper back in '41. It would be quite efficient at velocities above 1,000 m./sec., and a rocket charge of about 65 per cent. of the final weight could be used for starting from the ground. If an artificial radio-active element could be developed to stay red or white hot while exposed to a current of compressed air, it might be used as a heat exchanger in conjunction with a jet-propelling plant. But the quantity of heat liberated per second must be kept low.

Palestine. V. N. M.

REVS AND BOOST

A Pertinent Query in Verse

WAS there ever a topic of conversation
With such an incredibly strong fascination
For drivers of airframes, with one or more motors,
A blower (or booster) and rotor (or rotors),
As that which involves revolutions per minute
Pro rata with inches of boost? They begin it
By talking at random of all sorts of things
Like high aspect ratios and loading of wings,
But, sure as your chickens will come home to roost,
They'll end up debating about revs and boost.
The question at issue is whether to use
Two thousand five hundred and plus three to cruise;
Or this is fantastic—too high or too low?—
For just what the problem is, I wouldn't know.
By way of a change they revert to the take-off,
And how many revs before props start to break off;
But I don't intend to rush in, as they say,
Where even the angels aren't sure of the way.
So I'll leave out the details from this dissertation
And only refer to the inter-relation
Of inches and revs in the broadest of terms,
For if one of the angels aforesaid confirms
The figures I give you, another denies them,
And who should know best but the birdman who flies them?
Yet heated controversy goes on for ever
Where two or three pilots are gathered together.
At Flights, in the Mess—most of all at the bar—
Whatever they're doing, wherever they are,
From morn until even, by day and by night,
They talk revs and boost with the keenest delight.
They argue when working, when eating, when drinking,
And when they're asleep they must still go on thinking
In terms of the inches of boost on the clock
To balance the revs without bursting the block.
One spares the boost and relies on rotations,
Another agrees, but with some reservations;
But then there's a third, who revs her up faster;
He claims that it's courting the direct disaster
To think of the pots while forgetting the bearings.
And so they go on—multifarious airings
Of widely diverse, contradictory views
On what are the proper proportions to use.
With so much in dispute, what I can't understand
Is that all of them manage to take off and land.
They can't all be right, yet they say if you're wrong,
Your engines—perhaps even you—won't last long
Then how can it be, when it's all so uncertain,
That fifty per cent. haven't gone for a Burton?

"FIREFLY."

SERVICE AVIATION

Royal Air Force and Naval Air Arm News and Announcements

PIN-POINTERS: These Halifax III As were used to detect Jap radar stations for Liberators of S.E.A.C. to wipe out. They carried 690 gallons of extra fuel in the bomb-bays.

Royal Air Force Awards

THE KING has been graciously pleased to approve the following awards in recognition of gallantry and devotion to duty in the execution of air operations against the enemy.

Bar to Distinguished Service Order

Wing Cdr. K. J. LAWSON, D.S.O., D.F.C., R.A.F.V.R., No. 405 (R.C.A.F) Sqn. (with effect from June 1st, 1945) (since deceased).—Wing Cdr. Lawson had a long record of operational flying. Since his last award he has participated in numerous attacks against heavily defended targets. This officer has proved himself an outstanding leader with a high sense of devotion to duty and a fearlessness which has inspired confidence in his less experienced subordinates. Both in the air and on the ground Wing Cdr. Lawson has displayed great zeal and efficiency.

Bar to Distinguished Flying Cross

Act. Flt. Lt. D. SWAFFIELD, D.F.C., R.A.F.V.R., No. 635 Sqn.
Act. Flt. Lt. J. W. WATKINS, D.F.C., R.A.F.V.R., No. 109 Sqn.
F/O. F. A. W. CLAY, D.F.C., R.A.F.V.R., (Bomber Support Development Unit).
F/O. F. COUSINS, D.F.C., R.A.F.V.R., No. 405 (R.C.A.F.) Sqn.
F/O. W. R. DRINKWATER, D.F.C., R.A.F.V.R., No. 7 Sqn.
F/O. N. E. LITCHFIELD, D.F.C., R.A.F., No. 105 Sqn.
F/O. G. D. MOIR, D.F.C., R.A.F.V.R., No. 97 Sqn.
F/O. H. J. ROCK, D.F.C., R.A.F.V.R., No. 7 Sqn.
F/O. E. SOUTHALL, D.F.C., R.A.F.V.R., No. 1409 Flt.
F/O. W. A. STONEHAN, D.F.C., R.A.F.V.R., No. 7 Sqn.
F/O. H. WILTSHIRE, D.F.C., R.A.F.V.R., No. 158 Sqn.
F/O. R. H. YOUNGMAN, D.F.C., R.A.F.V.R., No. 1409 Flt.
Act. Sqn. Ldr. J. GOOD, D.F.C., R.A.A.F., No. 466 (R.A.A.F.) Sqn.
F/O. J. TUDBERRY, D.F.C., R.A.A.F., No. 10 Sqn.
Act. Wing Cdr. B. F. N. RAWSON, D.F.C., R.C.A.F., No. 405 (R.C.A.F.) Sqn.
Act. Sqn. Ldr. T. CAMPBELL, D.F.C., R.C.A.F., No. 97 Sqn.
Act. Sqn. Ldr. J. COMAB, D.F.C., No. 105 Sqn.
Act. Sqn. Ldr. W. F. EDWARDS, D.F.C., R.C.A.F., No. 83 Sqn.
Act. Sqn. Ldr. F. M. FALLS, D.F.C., R.C.A.F., No. 83 Sqn.
Wing Cdr. J. S. HAMILTON, D.F.C., A.F.C., R.A.F.V.R.
Act. Wing Cdr. A. D. MITCHELL, D.F.C., A.F.C., R.A.F.
Act. Sqn. Ldr. H. AMBROSE, D.F.C., R.A.F.V.R., No. 181 Sqn.
Act. Sqn. Ldr. A. J. REEVES, D.F.C., R.A.F.V.R., No. 74 Sqn.
Flt. Lt. G. G. TOZER, D.F.C., R.A.F.V.R., No. 4 Sqn.
Flt. Lt. A. G. WOODS, D.F.C., R.A.F.V.R., No. 605 Sqn.
F/O. F. C. COOKE, D.F.C., R.A.F.V.R., No. 357 Sqn.

Badge of No. 836 Squadron, Naval Air Arm—"Mari Coeloque" (By Sea and Sky.) On a field barry wavy white and blue, a winged lion rampant, red.

Distinguished Flying Cross

Act. Flt. Lt. T. C. OLSEN, R.C.A.F., No. 83 Sqn.
Act. Flt. Lt. L. J. E. G. POIRIER, R.C.A.F., No. 425 (R.C.A.F.) Sqn.
Act. Flt. Lt. R. G. REID, R.C.A.F., No. 115 Sqn.
Act. Flt. Lt. L. O. SIMONSON, R.C.A.F., No. 420 (R.C.A.F.) Sqn.
F/O. J. C. ALDAN, R.C.A.F., No. 420 (R.C.A.F.) Sqn.
Flt. Lt. W. B. COOKSON, No. 462 (R.A.A.F.) Sqn.
Flt. Lt. D. TWIST, R.N.Z.A.F., No. 106 Sqn.
Act. Flt. W. P. MOFFAT, R.N.Z.A.F. No. 138 Sqn.
Wing Cdr. V. S. H. DUCLOS, R.A.F.V.R., No. 45 Sqn.
Act. Wing Cdr. I. N. BAYLES, R.A.F.V.R., No. 273 Sqn.
Act. Wing Cdr. L. B. ERCOLANI, D.S.O., R.A.F.V.R., No. 159 Sqn.
Act. Wing Cdr. J. C. PAISH, R.A.F.O., No. 680 Sqn.
Act. Wing Cdr. E. S. SMITH, A.F.C., A.A.F., No. 264 Sqn.
Act. Sqn. Ldr. J. H. CURRIE, R.A.F.V.R., No. 4 (R.I.A.F.) Sqn.
Act. Sqn. Ldr. S. A. SHARPE, R.A.F., No. 358 Sqn.
Act. Sqn. Ldr. R. E. G SHEWARD, R.A.F.V.R., No. 266 Sqn.
Act. Sqn. Ldr. J. G. WALKER, R.A.F.V.R., No. 209 Sqn.
Act. Sqn. Ldr. T. N. O. WHITE, R.A.F.V.R.
Flt. Lt. W. A. ALLINSON, D.F.M., R.A.F., No. 140 Sqn.
Flt. Lt. P. J. ANSON, R.A.F.V.R., No. 135 Sqn.
Flt. Lt. K. R. BOOTH, D.F.M., R.A.F.V.R., No. 680 Sqn.
Flt. Lt. G. MacD. BRAIDWOOD, R.A.F.V.R., No. 322 Sqn.
Flt. Lt. E. W. D. CREED, R.A.F.V.R., No. 43 Sqn.
Flt. Lt. J. P. BROWN, R.A.F.V.R., No. 680 Sqn.
Flt. Lt. S. N. CHILTON, R.A.F.V.R., No. 113 Sqn.
Flt. Lt. W. O. DEEKS, R.A.F.V.R., No. 69 Sqn.
Flt. Lt. S. A. EBDON, R.A.F.V.R., No. 209 Sqn.
Flt. Lt. P. C. ELLIS, R.A.F.V.R., No. 613 Sqn.
Flt. Lt. I. A. S. GIBSON, R.A.F.V.R., No. 28 Sqn.
Flt. Lt. E. N. GODFREY, R.A.F., No. 16 Sqn.
Flt. Lt. D. H. HULME, R.A.F.V.R., No. 357 Sqn.
Flt. Lt. D. C. MARSHALL, R.A.F.V.R., No. 305 Sqn.
Flt. Lt. A. A. D. MONTAGUE-BROWNE, R.A.F.V.R., No. 211 Sqn.
F/O. D. POLLARD, R.A.F.V.R., No. 51 Sqn. (with effect from December 31st, 1944) (since deceased).
Act. Sqn. Ldr. R. P. M. WADE, R.A.F.O., No. 140 Sqn.
Flt. Lt. R. W. QUIXLEY, R.A.F.V.R., No. 28 Sqn.
Flt. Lt. A. H. RIECK, R.A.F.V.R., No. 177 Sqn.
Flt. Lt. G. ROBERTSON, R.A.F.V.R., No. 605 Sqn.
Flt. Lt. E. SLINGER, R.A.F.V.R., No. 113 Sqn.
Flt. Lt. P. N. SMITH, R.A.F.V.R., No. 211 Sqn.
Flt. Lt. H. B. THOMSON, R.A.F.V.R., No. 21 Sqn.
Flt. Lt. W. A. THORNE, R.A.F.V.R., No. 4 Sqn.
Flt. Lt. G. F. THORNTON, R.A.F.V.R., No. 2 Sqn.
Flt. Lt. J. F. WEBSTER, R.A.F., No. 464 (R.A.A.F.) Sqn.
Flt. Lt. H. F. WHIDBORNE, R.A.F.V.R., No. 30 Sqn.
Flt. Lt. M. R. DAVISON, R.A.F., No. 358 Sqn.
Act. Flt. Lt. E. HOLMES, R.A.F.V.R., No. 35 Sqn. (with effect from May 21st, 1944).
Act. Flt. Lt. D. L. HUGHES, R.A.F.V.R., No. 266 Sqn.
Act. Flt. Lt. K. W. JONES, R.A.F.V.R., No. 358 Sqn. (since deceased).
F/O. T. N. ALLEN, R.A.F.V.R., No. 117 Sqn.
F/O. R. E. ASTLEY, R.A.F.V.R., No. 113 Sqn.
F/O. A. BEGG, R.A.F.V.R., No. 211 Sqn.
F/O. D. B. BROWN, R.A.F.V.R., No. 680 Sqn.
F/O. L. J. CLAYDON, R.A.F.V.R., No. 356 Sqn.
F/O V. W. CORNWELL, R.A.F.V.R., No. 69 Sqn.
F/O. F. W. COX, R.A.F.V.R., No. 79 Sqn.
F/O. M. P. FISHER, R.A.F.V.R., No. 258 Sqn.
F/O. GOLDING, R.A.F.V.R., No. 215 Sqn.
F/O. W. C. HEATH, R.A.F.V.R., No. 16 Sqn.
F/O. C. H. HEDLEY, R.A.F., No. 358 Sqn.
F/O. D. F. W. HINTON, R.A.F.V.R., No. 135 Sqn.
F/O. C. E. M. B. HOLE, R.A.F.V.R., No. 607 Sqn.
F/O. M. HUSBAND, R.A.F.V.R., No. 258 Sqn
F/O. W. H. JOHNSON, D.F.M., R.A.F.V.R., No. 605 Sqn.
F/O. R. A. LACEY, R.A.F.V.R., No. 211 Sqn.
F/O. C. G. MONK, R.A.F.V.R., No. 247 Sqn.
F/O. J. C. MUMFORD, R.A.F.V.R., No. 146 Sqn.
F/O. S. A. PICKARD, R.A.F.V.R., No. 146 Sqn.
F/O. G. K. SENIOR, R.A.F., No. 69 Sqn.
F/O. P. STEAD, R.A.F.V.R., No. 258 Sqn.
F/O. R. VART, R.A.F.V.R., No. 258 Sqn.
F/O. N. J. WILLOUGHBY, R.A.F.V.R., No. 464 (R.A.A.F.) Sqn.
P/O. G. M. R. EASTWOOD, R.A.F.V.R., No. 266 Sqn.
P/O. A. L. GALLANTREE, R.A.F.V.R., No. 107 Sqn.
P/O. D. C. H. REX, R.A.F.V.R., No. 56 Sqn.
W/O. R. J. BAKER, R.A.F.V.R., No. 28 Sqn.
W/O. D. M. BECK, R.A.F.V.R., No. 83 Sqn. (with effect from August 12th, 1944) (since deceased).
W/O. M. J. CROGHAN, R.A.F.V.R., No. 258 Sqn.
W/O. M. E. DEWING, R.A.F.V.R., No. 28 Sqn.
W/O. F. J. KING, R.A.F.V.R., No. 177 Sqn.
W/O. (now P/O.) C. F. KIRBY, R.A.F.V.R., No. 358 Sqn.
W/O. W. J. PERRY, R.A.F.V.R., No. 177 Sqn.
W/O. J. SWIFT, R.A.F.V.R., No. 69 Sqn.
W/O. N. L. WOOLSEY, R.A.F.V.R., No. 357 Sqn.
W/O. A. WRAGG, R.A.F.V.R., No. 28 Sqn.
Act. Sqn. Ldr. P. N. STACEY, R.A.A.F., No. 211 Sqn.
Act. Sqn. Ldr. R. D. WILLIAMS, R.A.A.F., No. 215 Sqn.
Flt. Lt. B. C. OGILVIE, R.A.A.F., No. 4 Sqn.
F/O. J. W. THORPE, R.A.A.F., No. 69 Sqn.
P/O. F. B. LONG, R.A.A.F., No. 355 Sqn.
W/O. F. A. A. FOLEY, R.A.A.F., No. 215 Sqn.
Act. Sqn. Ldr. H. A. L. SIMPSON, R.C.A.F., No. 613 Sqn.
Flt. Lt. C. D. BARNETT, R.C.A.F., No. 107 Sqn.
Flt. Lt. J. H. CARTMELL, R.C.A.F., No. 140 Sqn.
Flt Lt. C. S. GILLIATT, R.C.A.F., No. 107 Sqn.
Flt. Lt. H. W. SETON, R.C.A.F., No. 258 Sqn.
Flt. Lt. T. S. SHEPPARD, R.C.A.F., No. 261 Sqn.
Flt. Lt. R. T. WALKER, R.C.A.F., No. 146 Sqn.
F/O. J. A. J. C. ANDERSON, R.C.A.F., No. 20 Sqn.
Flt. Lt. M. M. ENGINEER, R.I.A.F., No. 3 (R.I.A.F.) Sqn.
F/O. R. M. ENGINEER, R.I.A.F., No. 9 (R.I.A.F.) Sqn.
F/O. S. K. MUKERJEE, R.I.A.F., No. 9 (R.I.A.F.) Sqn.

Roll of Honour

Casualty Communiqué No. 544.

THE AIR MINISTRY regrets to announce the following casualties on various dates. The next of kin have been informed. Casualties "in action" are due to flying operations against the enemy; "on active service" includes ground casualties due to enemy action, non-operational flying casualties, fatal accidents and natural deaths.

Of the names in this list 171 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

KILLED IN ACTION.—Flt. Sgt. A. Aherne; W/O. J. J. Brogan; Flt. Lt. M. R. Clark; Flt. Sgt. L. S. Cuthbert; F/O. C. A. H. F. Defraigne; F/O. G. Dixon; F/O. E. H. Donne; Sgt. K. B. Earl; F/O. J. W. Freeman; Sgt. E. H. Garbutt; Sgt. G. N. Graham; F/O. E. M. Hales; Flt. Sgt. F. A. Harris; Flt. Sgt. J. F. C. Hawkins; Sgt. J. L. J. Hulse; Act. Wing Cdr. P. A. Kilebee, D.S.O., D.F.C., A.F.C.; F/O. E. J. Knowles; Flt. Sgt. T. Laidlaw; Sgt. L. L. Laming; Sgt. P. B. Langhorne; F/O. J. P. Leavy; Flt. Sgt. L. C. Loveless; Sgt. S. W. Lowe; F/O. A. McGregor; L.A/C. F. McNairney; W/O. W. R. Mills; Sgt. F. W. Mitchell; W/O. G. Myers; F/O. J. K. P. Nash; F/O. P. E. Nettlefield; Flt. Sgt. G. B. How; Sgt. D. S. Potter; Sgt. G. D. T. Rowe; Sgt. A. R. Simmonds; Flt. Lt. N. Smith; F/O. T. D. Taylor; Flt. Sgt. J. B. Walker; Sgt. J. Whitbread; Sgt. C. C. Young.

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. R. Hamilton; F/O. J. M. Hartman; Sgt. R. A. Rowley; Flt. Lt. C. G. Robertson, D.F.C.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Lt. J. Stevens; F/O. P. E. Tompkins; Sgt. I. Williams.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. G. F. D. Abayasekera; P/O. G. V. Acheson; Sgt. R. E. Addis; Flt. Sgt. S. W. Ainsworth; Sgt. G. Allenby; Sgt. P. D. Andrew; Flt. Sgt. J. Bailey; P/O. R. W. Bailey; Sgt. L. E. J. Baily; F/O. G. Baker; P/O. P. J. Baker; P/O. B. O. Baldwin; Flt. Sgt. J. W. Barber; Flt. Sgt. W. J. H. Beardsmore; Flt. Sgt. H. A. Beverton; Sgt. J. Birch; Sgt. P. W. Bishop; Sgt. A. Brewster; Flt. Sgt. R. A. J. Brimicombe; F/O. A. H. Brindley; Act. Flt. Lt. E. Broadbent; Flt. Sgt. A. S. Bromley; Sgt D. R. Brown; F/O. D. J. Bryant; Flt. Sgt. J. Charlton; Sgt. R. J. Chatwin; Sgt. I. L. Chittock; Sgt. D. J. K. Churchouse; P/O. I. D. H. Clarson; Sgt. K. Clinch; Flt. Sgt. P. H. Clucas; Flt. Sgt. K. S. Collins; Sgt. J. H. Cooper; Sgt. T. J. Crabtree; Sgt. E. Critchley; F/O. R. I. H. Davies; Sgt. V. Davies; Sgt. W. Davis; Sgt. R. S. Dickinson; F/O. J. W. Downing; Sgt. W. A. Drewett; F/O. R. H. Duncanson; Sgt. A. K. Edgar; Sgt. T. Edwards; F/O. K. Eastwood; Sgt. R. E. Faulkner; Sgt. P. B. Feltham; Sgt. R. Fenson; F/O. G. Ferguson; P/O. M. I. J. Fitzgerald; Sgt. D. T. Forrest; P/O. R. B. Garside; Sgt. J. M. Gittoes; Sgt. D. C. K. Grant; Flt. Sgt. L. W. Guggiari; P/O. G. P. Guy; Sgt. E. W. Haigh; F/O. W. T. Harding; Flt. Sgt. W. T. Harley; Sgt. D. J. Harvey; P/O. E. T. Heard; P/O. A. F. Heath; Sgt. E. Henley; Flt. Sgt. G. D. Hetherington; Flt. Sgt. J. Hewitt; F/O. A. W. Hickling; Sgt. F. W. Holroyd; Act. F/O. J. Isaac; Flt. Sgt. A. W. Jackson; Sgt. S. Jackson; Sgt. R. H. Julian; Sgt. A. G. Kerr; P/O. G. A. Langford; Flt. Sgt. R. D. Langford; Flt. Sgt. J. Law; P/O. D. Levens; Sgt. R. Litterick; F/O. J. W. Lloyd; Sgt. C. J. Ludlow; Sgt. A. Lunt; Flt. Sgt. P. Lunt; Sgt. S. McLenaghan; Flt. Sgt. J. L. T. Mannion; Sgt. D. L. Mardling; Flt. Sgt. D. Marriott; Flt. Lt. G. A. Marrows; P/O. D. W. Marvin; Sgt. G. W. Mawson; P/O. J. H. Meyer; Sgt. N. R. Millward; Sgt. S. Minnis; F/O. M. P. Moreton; W/O. J. P. Organ; F/O. G. W. Owen; F/O. J. F. Parry; Sgt. J. E. Pinnock; Flt. Sgt. F. Powls; F/O. C. C. Price; Flt. Sgt. W. W. Rice; Sgt. T. R. Riley; Sgt. A. T. Rogers; Flt. Lt. G. G. Rogers; P/O. B. L. Rowland; Sgt. J. T. Saunders; F/O. P. R. Sewell; Sgt. H. Shakespeare; Sgt. J. H. Sheehan; Sgt. P. J. Simpson; Sgt. A. L. Smith; F/O. A. T. Smith; Sgt. E. L. Smith; Flt. Lt. A. F. S. Somer; Flt. Sgt. R. A. Sparkes; Flt. Sgt. W. Steane; Sgt. E. J. Stone; W/O. G. H. Stratford; Sgt. S. T. Tanser; Sgt. D. R. Tomlinson; F/O. H. R. Tribbeck; Act. Flt. Lt. T. R. Poynton; Flt. Lt. T. Rawlinson; Act. Flt. Lt. A. T. Richards; Flt. Sgt. J. J. Rowland; Sgt. M. Rume; Flt. Sgt. R. Scott; P/O. J. A. Snowdon; Sgt. R. T. Taylor; Sgt. H. G. Trump; Sgt. H. J. Walker; Act. F/O. A. V. H. Wardle, D.F.C.; Flt. Sgt. P. C. Warwick; Act. Sqn. Ldr. A. W. Watson, D.F.C.; P/O. P. R. Wood; Sgt. G. K. Woodward; P/O. D. E. Woolley; F/O. R. J. Wright; Flt. Sgt. M. A. Zollo.

WOUNDED OR INJURED IN ACTION.—Flt. Lt. D. M. Grantham; Sgt. J. Hatfield; Sgt. W. McFadyen.

MISSING, BELIEVED KILLED IN ACTION.—Flt. Sgt. W. A. Collins; F/O. L. M. J. Grant; Flt. Lt. R. Gray; Sgt. A. W. Greenhough; Sgt. A. F. Herd; Sgt. A. M. Lang; Flt. Sgt. E. E. Leitwich; Sgt. D. C. Oakden; Flt. Sgt. E. Peters; Flt. Sgt. J. D. Silkstone; Sgt. H. Woodards.

MISSING.—Sgt. J. H. Bentley; Flt. Sgt. K. Bowler; Flt. Sgt. G. B. Breachmore; P/O. J. A. Brydson; Flt. Sgt. K. H. Choak; Sgt. T. Churchill; Flt. Sgt. A. J. Clifton; Flt. Lt. C. Cooper, D.F.M.; Sgt. W. Cummins; Flt. Sgt. J. G. Day; Sgt. H. Denby; W/O. M. J. Dunn; Sgt. F. A. Edwards; Flt. Sgt. A. H. E. Floyd; F/O. H. Frost, D.F.M.; Sgt. J. W. Geran; Sgt. J. Hanlon; Flt. Sgt. T. Higginbotham; F/O. A. A. Homburg; F/O. T. H. Howell; Sgt. F. Hume; Sgt. P. N. Hyde; Flt. Sgt. F. R. Jones; F/O. S. P. A. Mansell; Flt. Sgt. J. Marrinan; Flt. Lt. S. C. Matthews, D.F.C.; F/O. J. R. Mearns; Flt. Sgt. R. E. Moore; F/O. M. Morrison; Sgt. P. S. Nelson; Flt. Sgt. E. A. Percival; Sgt. A. R. Phipps; W/O. L. Reed; Flt. Sgt. D. F. Reid; Flt. Sgt. J. L. Richardson; Sgt. A. M. Rogers; Flt. Sgt. A. M. Ross; Flt. Sgt. J. Stobbs; Sgt. F. A. Taylor; Sgt. H. W. Taylor; Flt. Lt. F. J. Toon, D.F.C.; Flt. Lt. E. S. Vale; F/O. J. W. Vinall; Flt. Sgt. W. G. Yeomans.

KILLED ON ACTIVE SERVICE.—L.A/C. L. F. Allen; F/O. A. M. Ankers; F/O. C. D. Ball; L.A/C. R. D. Brown; Sgt. B. J. Patch; Flt. Lt. J. L. H. Richards; F/O. W. E. Robinson; F/O. R. A. Scrase; Air Cmdre. D. J. Waghorn, A.F.C.; A/C.1 C. W. White.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Flt. Sgt. T. J. M. Coad; Flt. Sgt. A. D. C. Jamieson; W/O. P. Lavin.

WOUNDED OR INJURED ON ACTIVE SERVICE.—F/O. G. Atkinson; L.A/C. P. Bellard; Flt. Sgt. W. McQ. Hay; P/O. A. B. Kyle; Sgt. L. Pilling.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—L.A/C. F. H. Morrish; L.A/C. R. J. Waite.

DIED ON ACTIVE SERVICE.—L.A/C. F. Baldwin; L.A/C. F. Bush; Sgt. C. W. Cradduck; L.A/C. R. M. Glendinning; L.A/C. A. E. Newman; L.A/C. B. Risley; Sgt W. Rodgers; Sgt. J. T. Sharman; L.A/C. A. R. Smith; A/C.1 R. B. Woodward.

Women's Auxiliary Air Force

DIED ON ACTIVE SERVICE.—L.A/CW. D. Booth.

Badge of No. 881 Squadron, Naval Air Arm—"Ense Constanter Alato" (Steadfastly with winged sword.) On a blue field, in base water barry wavy white and blue, a sword in pale, point downwards, white winged, gold.

Royal Australian Air Force

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. G. R. Conley; Flt. Sgt. I. H. Jury; P/O. W. D. Mitchell.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—F/O. J. O. Klippel.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. G. E. Beckhouse; F/O. N. R. M. Clark; P/O. D. C. Crosthwaite; Flt. Sgt. G. D. Currey; Flt. Sgt. J. B. Duell; Flt. Sgt. J. H. Elder; Flt. Sgt. J. O. Harris; F/O. D. L. Haynes; F/O. J. P. Hodges; Act. Sqn. Ldr. G. F. Jackson; W/O. S. G. Lee; P/O. R. H. Leonard; P/O. A. D. MacDougall; Flt. Sgt. F. N. McDonough; Act. F/O. G. E. Maxwell; W/O. K. T. Millikan; F/O. F. E. O'Connell; P/O. A. W. M. Parsons; F/O. A. R. Scanlon; Act. Flt. Lt. G. C. Startin; W/O. C. R. Stevenson; Flt. Sgt. W. Tudberry; Flt. Sgt. W. I. Warrington.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW REPORTED KILLED IN ACTION.—W/O. D. B. Kairton.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—W/O. H. G. Carlyle.

MISSING, BELIEVED KILLED IN ACTION.—P/O. A. P. Smith.

MISSING.—F/O. I. R. Cowan, D.F.C.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—F/O. F. W. Douglas; Flt. Lt. H. R. Hannaford, D.F.C.

DIED ON ACTIVE SERVICE.—Flt. Sgt. T. H. Hofto.

Royal Canadian Air Force

KILLED IN ACTION.—Flt. Sgt. D. Bellantino; Flt. Sgt. P. W. Davies; F/O. W. Edmondson; F/O. M. G. Gant; F/O. R. J. W. Hall; W/O. S. E. Hencher; Flt. Sgt. G. W. Laut; F/O. T. MacL. Lincoln; F/O. D. R. McGillivray; Flt. Sgt. R. A. Paul; F/O. A. V. Plante; P/O. J. J. Yule.

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. C. E. Orser.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Flt. Lt. G. W. Taylor.

MISSING, BELIEVED KILLED IN ACTION.—F/O. G. Couldrey; F/O. J. P. Marchant; Sqn. Ldr. L. A. Moore, D.F.C.; Flt. Lt. S. W. Morris; F/O. W. E. Thoroldson.

MISSING.—F/O. L. R. Aljoe; F/O. R. A. H. Allen; F/O. W. Anderson; Flt. Lt. J. B. Barnes; P/O. R. M. Botting; Flt. Sgt. L. W. Brennan; F/O. W. H. Brooks; W/O. J. E. Bunn; Sqn. Ldr. W. R. Christison, D.F.C.; F/O. J. W. Dorrell; Flt. Lt. J. P. Duggan; F/O. D. Frame; Flt. Lt. J. F. Hadley; Sgt. J. W. Inman; Flt. Sgt. C. T. Johnson; W/O. J. MacD. Jones; P/O. J. B. Ketchen; F/O. W. F. Kilpatrick; F/O. J. G. Lee; Flt. Sgt. E. Lindsay; F/O. R. R. Little; F/O. J. R. McCollum; Flt. Sgt. W. E. McDonald; Flt. Sgt. J. MacKenzie; F/O. G. D. McLean; P/O. A. K. McMillan; F/O. F. J. Manning; F/O. M. Ornstein; F/O. S. Pascal; Flt. Sgt. C. E. Root; P/O. F. B. Trent; F/O. G. A. Zuback.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sqn. Ldr. J. E. Hogg; F/O. J. W. Newman.

BRAZILIAN VISITORS: Members of the Brazilian Air Force being shown one of the classrooms at No. 1 School of Technical Training, Halton.

SERVICE AVIATION

KILLED ON ACTIVE SERVICE.—P/O. R. S. Bellis; F/O. G. A. Sullivan.

DIED ON ACTIVE SERVICE.—A/C.1 L. Blondeau; P/O. E. B. Forsythe.

Royal New Zealand Air Force

KILLED IN ACTION.—F/O. G. D. Hudson, A.F.C.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. A. C. Fletcher.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Act. F/O. N. R. Overend; Flt. Sgt. C. L. Saundercock; P/O. H. Whittington.

South African Air Force

KILLED IN ACTION.—W/O. G. J. Durant; Lt. J. B. Dutoit; Lt. H. N. Lawless; Lt. K. Logan; W/O. J. H. Pieters.

MISSING, NOW PRESUMED KILLED IN ACTION.—Lt. G. R. Bell; 2/Lt. C. W. Heaven; Act. Air Sgt. J. P. Snyman; Act. Air Sgt. T. Treleaven; Lt. R. A. Zimmerman.

Casualty Communique No. 545

Of the names in this list 174 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

KILLED IN ACTION.—F/O. R. M. Davidson; F/O. W. G. Flynn, D.F.M.; F/O. R. M. Gale; Sgt. J. Grady; Sgt. D. R. Hyslop; P/O. R. S. King; Sgt. C. B. Oultram; Flt. Lt. W. A. C. Patterson, D.F.C.; Flt. Sgt. F. W. H. Shorrock.

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. R. A. Burgess; Flt. Sgt. G. A. Heath; Flt. Lt. E. P. C. Kidd, D.F.C.; F/O. T. S. MacAulay; Flt. Sgt. H. Minshull; Flt. Sgt. A. D. Shopland.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—W/O. L. C. Evans; F/O. R. K. Stratford, D.F.M.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. D. Asquith; Sgt. J. Barber; Flt. Sgt. H. Barret; Sgt. M. B. P. Barrow; Sgt. V. L. Bennett; F/O. P. R. Billingsley; Sgt. W. B. Bishop; Sgt. E. Blackburn; P/O. A. J. Boyle; Sgt. W. W. Bright; Flt Sgt. A. T. Britchford; Sgt. R. T. Brown; F/O. A. Browne; F/O. W. M. Chant; Sgt. R. C. J. Cheesman; Sgt. J. Clarke; Flt. Sgt. W. A. Clevey; Sgt. A. C. Connor; F/O. E. J. Cooper; Flt. Sgt. R. H. Cooper; F/O. E. J. Dane; Sgt. G. F. Davis; Sgt. J. K. Dunne; Flt. Sgt. C. B. Dunthorne; Sgt. K. M. G. Durrant; Flt. Sgt. J. W. Eastman; Sgt. R. Edwards; Sgt. P. C. Eldridge; Sgt. F. J. Feakins; F/O. D. K. Foster; Sgt. E. D. Foulkes; Sgt. W. H. Francis; Sgt. A. Friesner; Sgt. D. J. Fuller; P/O. A. T. Gardner; Sgt. L. T. Gearing; Sgt. J. J. George; Sgt. J. Gill; Sgt. F. Goddard; Sgt. D. A. Goggin; Flt. Sgt. C. A. Goode; Sgt. D. A. Hadden; F/O. A. H. Hall; Sgt. G. H. Hall; Sgt. S. Hamilton; Sgt. G. F. Hancox; Sgt. V. A. Hanmer; F/O. S. J. Hanney; Sgt. N. Hornby; F/O. I. J. G. Hart; F/O. G. W. Hemsley; P/O. D. R. Hollingsworth; Flt. Sgt. B. J. Hudson; Sgt. W. Hunter; Flt. Lt. A. Hutchison; Sgt. J. E. Jennings; Flt. Sgt. N. W. Johnstone; F/O. J. F. H. Jolly; Sgt. A. H. Jones; Sgt. C. Jones; Sgt. S. L. W. Kelly; Sgt. A. W. Knapp; F/O. K. J. Lambert, D.F.C.; Sgt. J. T. Leitch; F/O. R. S. Ling; Flt. Sgt. J. J. Lovett; W/O. P. J. Lynes, D.F.M.; Sgt. T. F. McClay; Sgt. T. McCluskey; Sgt. A. P. C. McCulloch; Flt. Sgt. J. Manley; W/O. E. A. Mason; Sgt. H. A. Messenger; Flt. Lt. L. Miller; Sgt. F. Mitchell; Flt. Sgt. W. R. Morrell; Sgt. R. Morris; Sgt. F. C. Mustoe; Flt. Sgt. A. D. Neish; P/O. E. Nelson; F/O. C. J. Niblett; Sgt. A. C. Norris; W/O. S. Norris; Act. Sqn. Ldr. L. Ollier, D.F.C., A.F.M.; Sgt. E. Parry; Sgt. C. A. Partridge; P/O. G. F. Pearse; Sgt. C. F. Pope; Sgt. A. G. Porter; Act. Flt. Lt. E. J. Presland, D.F.C.; Sgt. D. C. Prior; Flt. Lt. F. R. Randall; Sgt. J. Ray; Flt. Sgt G. E. Reddish; Sgt. N. C. Richmond; Sgt. J. Robertson; F/O. V. A. Robertson; Sgt. R. Robinson; Sgt. A. F. Rowlands; Sgt. L. Salway; Sgt G. W. D. Scott; Sgt. J. J. Sillender; Flt. Lt. J. W. S. Skinner; P/O. A. E. Slade; Flt. Sgt E. G. Small; F/O. D. A. J. Smith; Sgt. F. R. Smith; W/O. J. C. Smith; F/O. L. J. Solomon; Sgt. F. W. Sowerby; Flt. Sgt. H. S. Thomas; Sgt. S. Thompson; Sgt. T. W. Thompson; Sgt. M. J. Treymayne; P/O. O. J. Turner; F/O. S. G. Turner; Flt. Lt. P. K. Twiss; Flt. Sgt. J. K. R. Vincent; Sgt. W. Wales; F/O. L. V. Warboys; Sgt. R. Ward; Sgt. B. D. M. Warren; Act. Sqn Ldr. W. G. Watson, D.F.C.; Sgt. G. West; Sgt. N. G. Whitley; F/O. H. Wilkins; F/O. F. Williams, D.F.M.; Sgt. G. N. Wise; Flt. Lt. E. D. Woodward; Flt. Sgt. R. A. Woolley.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. W. G. Tolley.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—F/O. J. T. Clifford; Wing Cdr. G. E. Harrison, D.F.C.; P/O. W. C. McCoy; F/O. N. MacKay; Sgt. T. A. McRobbie; Flt. Lt. N. E. Skinner, D.F.C.

MISSING, BELIEVED KILLED IN ACTION.—Flt. Lt. F. H. Bradford; Flt. Lt. J. Butler; F/O. P. A. Halliwell; Flt. Sgt. J. O. Jones; W/O. K. B. C. Williams.

MISSING.—Flt. Sgt. A. C. Beaton; Act. Flt. Lt. M. W. Bell; Flt. Sgt. H. V. Blakey; Sgt. D. Colquhoun; Sgt. R. H. Davies; Act. Flt. Lt. J. E. Dawes; Sgt. J. R. Dicken; Act. Sqn. Ldr. T. R. A. Dow, D.F.C.; F/O. J. G. H. M. Dunham; P/O. P. T. Edwards; Flt. Lt. J. S. Endersby; Flt. Lt. J. C. Francis; Flt. Sgt. M. V. Fuller; Flt. Sgt. P. J. Fulton; F/O. W. J. A. Gibb; W/O. A. T. Gill; Sgt. F. W. Goodenough; Sgt. G. T. Greenwood; Sgt. D. Gunn; Flt. Sgt. W. J. Haddon; Flt. Sgt. E. H. Hagyard; W/O. R. R. Hales; Sgt. R. J. Harford; Sgt. H. Hartley; F/O. M. D. Hayes; Flt. Sgt. W. Higgins; Sgt. L. A. Hill; Sgt. D. F. Hull; F/O. J. Jackson; Sgt. A. A. Jarvis; Flt. Lt. W. M. O. Jones; Flt. Sgt. J. R. King; Sgt. W. C. Lewis; Flt. Sgt. C. Madden; Sgt. B. C. Manning; F/O. J. R. D. Morgan, D.F.C.; W/O. A. G. T. Muttock; Flt. Sgt. R. Neal; F/O. A. J. Newell; Flt. Lt. G. A. Nicholls; Flt. Sgt. H. J. Nicholson; F/O. G. F. Orry; F/O. R. G. Perkins; Act. Wing Cdr. F. S. Powley, A.F.C., D.F.C.; Sgt. H. Prust; Flt. Lt. K. Pudsey, D.F.M.; Flt. Sgt. L. Robinson; Flt. Lt. S. T. Rouse; Sgt. C. F. Sadler; Flt. Sgt. L. G. Sims; L.A/C. G. W. Smith; F/O. L. S. Smith; Sgt. R. S. Smith; P/O. V. P. Smith; Flt. Sgt. G. F. C. Stephenson; F/O. H. A. Thomas; Flt. Sgt. R. H. A. Thorpe; Sgt. G. R. Wall; F/O. C. P. W. Warren; Flt. Sgt. P. J. Warrington; Flt. Sgt. R. C. S. Wells; Flt. Sgt. J. E. Wilkinson; F/O. J. Wotherspoon.

Badge of No. 1771 Squadron, Naval Air Arm—"Undaunted." On a blue field, an eagle, gold, in combat with a sea monster rising from water barry wavy in base, blue and white.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sgt. C. G. Acton; F/O. D. S. Dumble; F/O. D. P. Hallett; Sgt. S. W. Hutchinson; Sgt. T. Moule; F/O. E. Scott; Flt. Sgt. W. Wild.

KILLED ON ACTIVE SERVICE.—F/O. E. Artus; Flt. Sgt. S. J. Crawhall; Flt. Sgt. W. K. De Ver; Flt. Lt. P. Enderby; Sgt. C. E. Grevett; Sgt. N. Langford; Sgt. M. Musgrave; Flt. Lt. R. A. Shrubb; L.A/C. S. Talbot; Flt. Lt. J. P. Vickery.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. F. B. Law.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Flt. Sgt. R. Bill; L.A/C. W. I. Clayton; Flt. Sgt. L. R. Griffiths; Flt. Sgt. E. Lack; W/O. P. MacC. Stitt; L.A/C. W. H. Taylor.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Flt. Sgt. T. M. Gledhill; Sgt. S. H. C. Stagg.

DIED ON ACTIVE SERVICE.—Act. Cpl. W. H. Bates; F/O. P. D. W. Bushell; Cpl. J. A. Carlson; L.A/C. E. T. Clarke; Sgt. A. H. Collver; Cpl. T. H. Dawe; L.A/C. P. F. Edgeller; Cpl. W. M. C. McCormick; L.A/C. T. J. Martin; L.A/C. E. N. Peaper; Flt. Lt. N. C. Pye, D.F.C.; L.A/C. J. H. Scott; Cpl. R. P. Thomas; L.A/C. M. Wake; Act. Cpl. P. F. Wing.

Women's Auxiliary Air Force

DIED ON ACTIVE SERVICE.—A/CW.2 M. J. McGoldrick.

Royal Australian Air Force

KILLED IN ACTION.—P/O. A. J. Damm; P/O. G. A. Halliday; F/O. D. J. Watson.

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—W/O. A. M. Taylor.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. R. A. L. Reid; Flt. Sgt. C. D. Ryalls; Flt. Sgt. G. M. Walker.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED. KILLED IN ACTION.—Flt. Sgt. B. P. Bennett; Flt. Sgt. S. K. Black; Flt. Sgt. J. L. Brooks; P/O. E. R. Brown; F/O. J. S. Braithwaite; P/O. W. F. Collins; F/O. R. McK. Croft; F/O. E. A. Fayle; Flt. Sgt. P. S. Fleming; F/O. J. H. Irwin; F/O. G. A. Jacobson; F/O. J. A. U. Jamieson; Flt. Sgt. J. N. Keys; P/O. J. S. Lupton; P/O. M. F. J. McNamara; Flt. Sgt. G. H. Noakes; P/O. E. W. Page; W/O. F. A. Page; W/O. D. F. Phillips; Flt. Lt. W. N. Read; Flt. Sgt. B. L. Sheean; Flt. Sgt. C. Y. Warren; P/O. K. R. Warren.

WOUNDED OR INJURED IN ACTION.—F/O. S. J. Sykes, D.F.C.

MISSING.—Flt. Sgt. L. A. Bayley; W/O. A. S. Dickson; F/O. R. H. Golding; Act. Flt. Lt. A. P. Greenfield, P/O. K. Tate; F/O. B. S. Woolstencroft.

KILLED ON ACTIVE SERVICE.—Flt. Sgt. W. E. Bennett; W/O. E. J. Castor; P/O. J. E. Grayson; Flt. Sgt. M. B. Kilsby; F/O. R. G. Watts, D.F.C.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Flt. Sgt. T. Evans; Flt. Sgt. D. L. Hayes.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. J. G. Beilby; Sgt. M. D. D. MacFarlane; Flt. Sgt. E. A. Nayler.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Flt. Sgt. T. L. McDermott.

Royal Canadian Air Force

KILLED IN ACTION.—F/O. D. M. Armstrong; Flt. Sgt. A. Banks; P/O. M. W. Bredin; Flt. Lt. R. N. Ferris; Flt. Lt. R. C. Hamill; F/O. H. R. J. Hennessey; Sgt. L. G. Hinch; W/O. R. G. Hutton; F/O. F. M. Irwin; F/O. J. G. N. Lejambe; Sgt. G. T. Llewellin; Flt. Lt. R. W. Newton; P/O. C. W. Parrish; Flt. Lt. A. F. Penhale; W/O. A. J. G. Temple; F/O. J. E. Traill; P/O. C. H. Vickery; W/O. J. S. Wilson.

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—F/O. E. R. Evans, D.F.C.; F/O. D. C. Graham.

WOUNDED ON INJURED IN ACTION.—F/O. F. J. Kennelly.

MISSING.—F/O. S. M. Bonter; F/O. H. C. Byrd; F/O. A. E. Joynt; Sgt. D. C. Lawton; Sgt. P. Panasuk; Sgt. T. D. Scott.

DIED ON ACTIVE SERVICE.—L.A/C. W. H. Smith.

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Act. Flt. Lt. C. H. Masters; Act. Flt. Lt. C. F. Penfold.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—W/O. T. B. Brierley; W/O. D. M. Mathewson; P/O. P. C. Siddall.

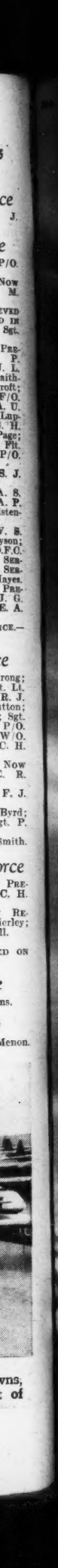
MISSING.—W/O. A. B. Clarke.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—W/O. E. O. England.

South African Air Force

KILLED IN ACTION.—Flt. Lt. F. L. Higgins.

Royal Indian Air Force

DIED ON ACTIVE SERVICE.—L.A/C. P. D. Menon.

POWERLESS FLEET: A mass of Horsas at Netheravon, on the Wiltshire Downs, where Transport Command studies all aspects of air transport, in the light of experience gained during the war in Europe.